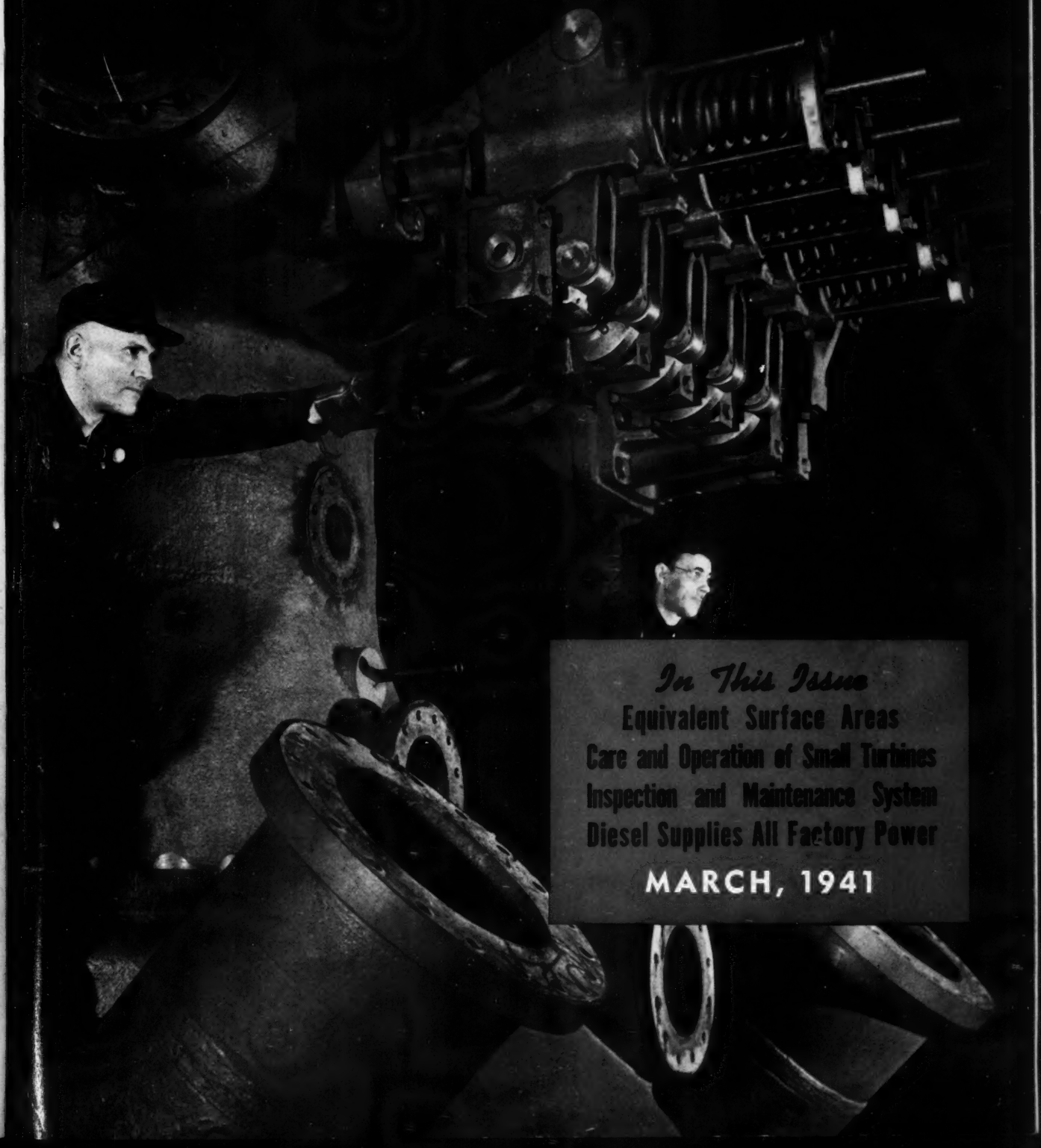
POWER PLANT ENGINEERING



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Equivalent Surface Areas

Care and Operation of Small Turbines

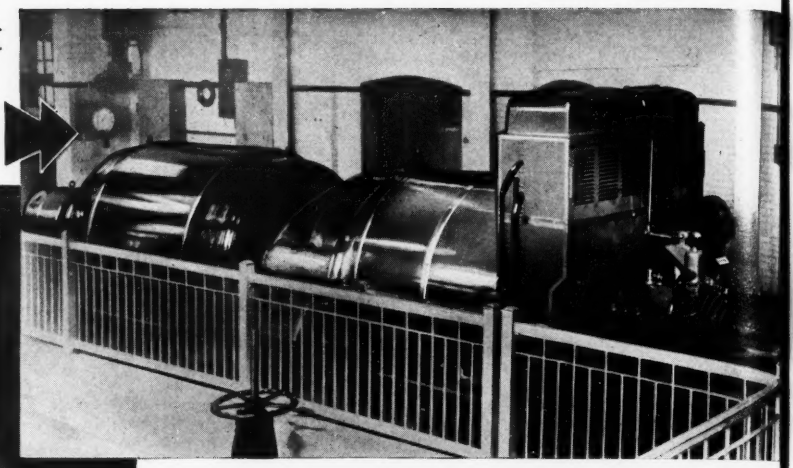
Inspection and Maintenance System

Diesel Supplies All Factory Power

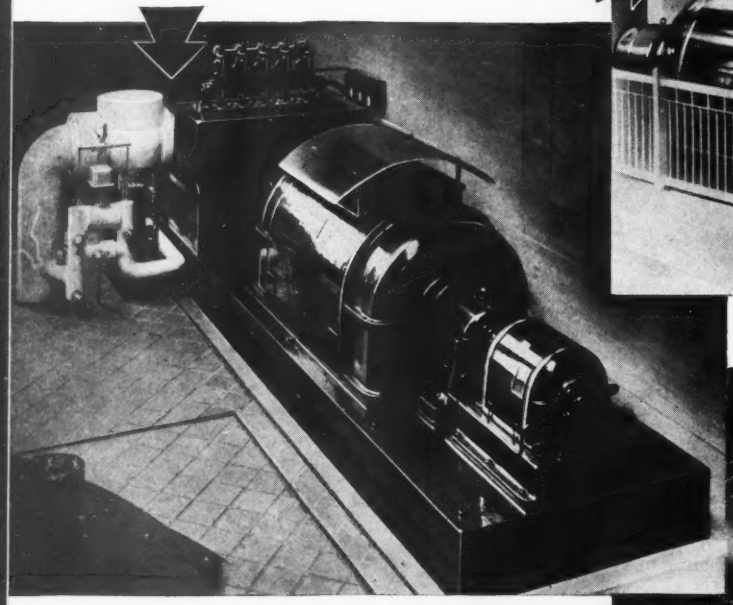
MARCH, 1941

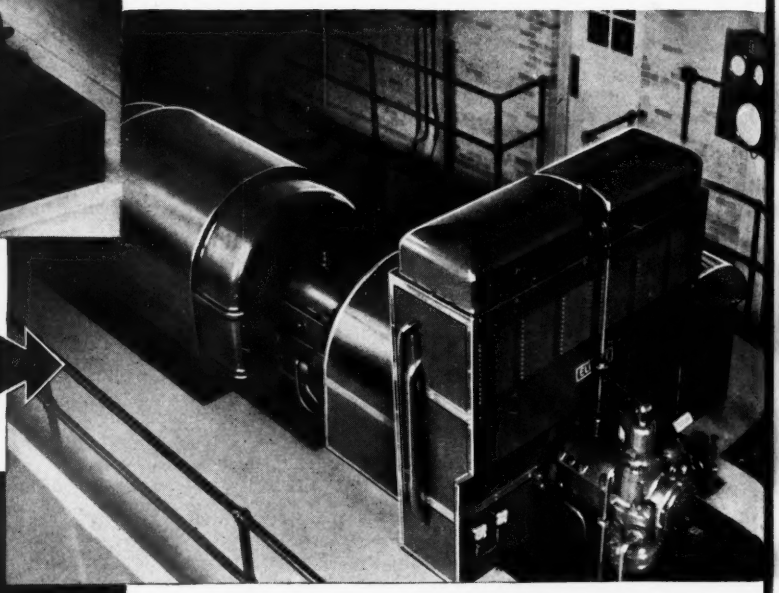
QUICK STARTERS · STREAM

An Elliott 5000-kw. straight condensing turbine-generator installation in a central station.



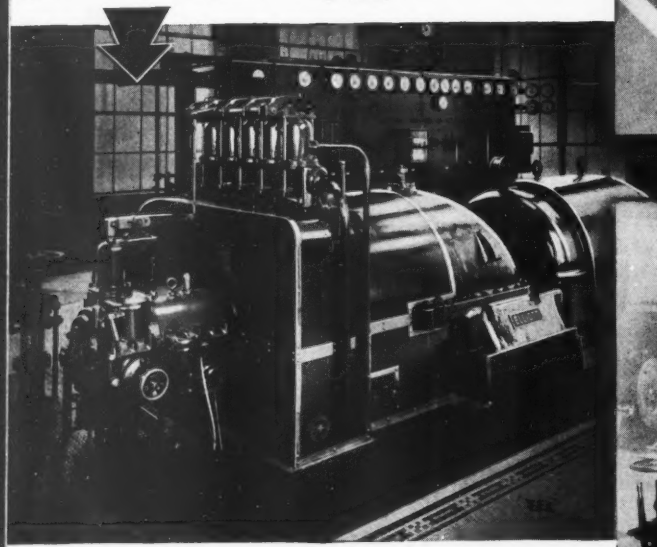
Elliott 2500-kw. quick-starting non-condensing turbine-generator in a utility standby plant. It enables full load to be picked up on the main unit in a matter of seconds.

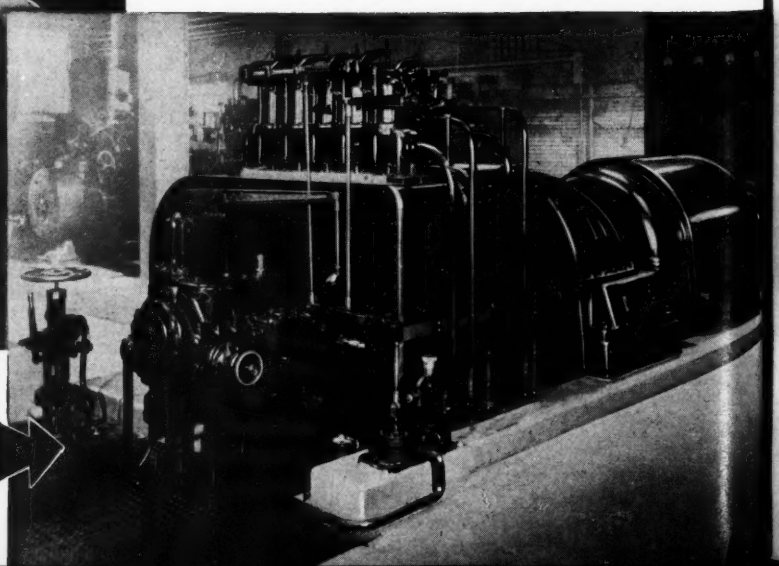




This Elliott 2500-kw. non-condensing turbine-generator in a university power plant was carefully applied to generate just enough power to provide the steam which is needed for heating. It operates in parallel with public utility power, and develops a substantial electrical load at very low unit cost.

This Elliott 1000-kw. turbine-generator replaced an 18-year old Elliott 500-kw. unit which had become too small for the textile mill load. It is an extraction turbine exhausting to an Elliott jet condenser which is used to heat storage water for process purposes.





An Elliott 1000-kw. condensing extraction turbine-generator unit in a meat packing plant. Steam is extracted at 125 lb. gage for use in steam engines.

H-641

POWER PLANT ENGINEERING

MARCH, 1941
VOLUME 45, NO. 3

Cover: The upper half of an 80,000 kw. turbine shell being built by General Electric Co. for the Duke Power Co. in North Carolina.

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THE VOICE OF INDUSTRY

ALFRED KAUFFMANN on the YOUNG MAN AND HIS FUTURE

NO CRYSTAL gazer — no palmist, no astrological reading can forecast your future, but what I can tell you is that, even though this world is in a turmoil, this is still a great country—the greatest in the world; that all this talk about there being no further opportunity in America for brains and initiative is rubbish—that the road in front of you young men is not blocked.

Some of you young men are going to carry on what others have started. You are going to sit where others are sitting, and attend to things which we now think so important. We may adopt all the policies we please, but how they will be carried out depends on you. All our work is going to be judged and praised or condemned by you.

While few if any of you young men will immediately be called upon to lead, you will find as time goes on and you step into higher positions, that no man, regardless of his qualifications or personal genius, can travel very far alone. The most he can do is to lead the way, and the success of his leadership depends almost entirely upon his organization following, not in numbers alone, but in the mental attitude these followers have.

If you aspire to be foreman or superintendent—chief draftsman or chief engineer—head of sales or finance—manager or president—a knowledge of men, an appreciation of their problems and needs, and of the factors making for their contentment and happiness, will supersede knowledge of technical processes, of salesmanship or finance. The handling of men is the most difficult problem in industry.

How to win confidence and cooperation, how to build up that team spirit that spells success, is one of the problems for which no specific solution has yet been found. Sometimes it is developed through the personality of the owner, through his fairness, his considerate attitude toward his men, through his qualities of leadership.

In the larger organization it can be developed through broad and liberal policies on the part of the company, supplemented by the ability of specialists at the head of well-organized personnel departments. In the smaller industries where close contact can be maintained by the employer, or by him through his superintendents and foremen, more satisfactory results can be obtained through less complex machinery.

The engineer has recognized this widening field. He is no longer confining himself to purely mechanical design and development, but has invaded the field of industrial relations, just as Frederick Taylor, the engineer, invaded the field of Shop Management, forty odd years ago, and devoted all his genius and all his energy to the development of that type of management which came to be known as "Scientific Management."

In any group of engineers there is a goodly percentage who are content to practice their profession without shouldering the responsibility which the quest for high sales or executive positions involves. This type of engineer fills a very useful niche in industry, and it is upon them that most of the burden of design and development falls. There is a smaller number, however, in whom desire for more compensation or higher position is ever present, and it is this group who show a greater aptitude for acquiring the necessary experience to qualify them for advancement in the business departments of a company.

What I want to do is to arouse you young engineers who are starting out in the world—to a realization that your trained mind can be applied to problems of production—to those of distribution—of sales—to the problems of finance, accounting and publicity—with as much chance of finding a worth-while solution as in the problems of engineering.

Don't miss an opportunity. If you start in the shop, drafting room or office, you should study and observe how tasks are performed. Never miss an opportunity to inspect equipment designed by yourself, other engineers, the company with which you are associated, and its competitors. Designs of others all have meritorious features which should be appreciated. Continually consider production economy, and the improving of shop methods.

Study the catalogs describing the products made, as you can learn a great deal there. Consider old problems or tasks from a new angle, and do not be content to solve or do them in the old conventional way. Ask questions; discuss your problems with others.

Remember, the employer is not responsible for your further education, that's up to you. Few are pushed up, but many are shoved out of the way because they permit themselves to remain on an unsound foundation.

ALFRED KAUFFMANN, president of Link-Belt Co. since 1924, is one of the recognized outstanding industrial leaders of America. In no small measure, his success is due to his knowledge of men and his appreciation of the need for co-operation in business today. Both of these are products of his own experience for he came up from the ranks, beginning at the bottom of the ladder and climbing rung by rung from draftsman to president. As an impatient young man he admits "I have done as much kicking in my time as anyone" but came to the conclusion that it doesn't pay and "if you want to kick, register it against yourself and rebel against any bad habits you may have."

When Mr. Kauffmann graduated from Pratt Institute of Brooklyn in 1901, Charles Pratt told the graduating class "Be true to your work and your work will be true to you." This was Mr. Kauffmann's concluding message in the commencement address from which these remarks were taken. The address was delivered on Jan. 29 when the first class of co-operative students, since the consolidation of Armour and Lewis Institutes into the Illinois Institute of Technology, was graduated.

Our First Line Of Defense

IN SAFEGUARDING the nation from attack by aggressor forces from across the seas, our first line of defense lies not so much in the strategic military outposts and bases in the Pacific and Atlantic Oceans as it does in the barriers surrounding our great industrial plants. Modern wars are won on the production lines of manufacturing plants. If these production lines can be kept intact, if their operation can be sustained without interruption by subversive interests, wars can go on; if not they are lost. Aside from all human and emotional aspects, the outcome of the present conflict is purely a question of resources, material and productive. In this country, for the present at least, there is little likelihood of direct attack upon manufacturing and power plants but undoubtedly there are forces in existence which seek to destroy them. In guarding against the operation of these forces one of the first essentials is adequate outdoor lighting. The view shown above represents an important part of such a protective lighting system designed by General Electric engineers for a large eastern industrial plant. Pendant luminaires using 10,000 lumen lamps and mounted 25 ft. above the ground literally flood the guard fence with light. The poles are set 8 ft. inside the fence to prevent tampering.

WITH THE EDITORS

◆ **RADIO PROGRAM . . .** Electrical engineers are now using a product of their brains to place before the public the role of the electrical engineering profession in the navy-defense industries, the production of electric power and research for defense. How appropriate it is that the American Institute of Electrical Engineers should use the radio as a medium through which to carry their messages to the millions of American citizens who are interested in following the progress of our national defense measures.

For the current series of broadcasts sponsored by the Institute, four fifteen minute periods have been engaged. On February 10 Commander E. W. Mills of the U. S. Navy Dept. told how the resources of electrical engineers are utilized in the Navy, assisted by Dean Joseph W. Barker of Columbia University. The next broadcast was on February 18, when Marvin W. Smith of the Westinghouse Co. and R. C. Muir of General Electric dealt with the activities of electrical engineers in the defense industries. This was followed a week later, February 25, by C. W. Kellogg, president of the Edison Electric Institute, covering the mobilization of the gigantic electric power facilities of the nation for defense, aided in the discussion by Dean Edward L. Moreland of the Massachusetts Institute of Technology. On March 4, at 10:15 Eastern Standard Time, over the N.B.C. Blue Network, the story of electrical research will be told by Dr. Frank B. Jewell, vice-president of the American Telephone and Telegraph Co., and others.

"Do it electrically" has long been a slogan used by the electrical industries, but, having invented and perfected the equipment and conceived the slogan, in their characteristically modest natures these same engineers are prone to cling to outmoded practices. The stories that could be built around the progress of electrical industries are full of romance, excitement, imagination and human experience extremely interesting to the public mind.

◆ **COAL FACTS . . .** Research has long been the tool with which engineers pry open the lid of nature's treasure chest. Inch by inch as the cover is raised secrets are revealed and each new fact discovered seems to challenge the truth of some things thought to have been proven, and point to new unexplored fields. Among the agencies which have contributed most to the useful information available to engineers is the United States Bureau of Mines whose work in the field of coal preparation and burning has been of extreme value to the power plant engineer. Reporting on the work of the Bureau for the fiscal year 1940, A. C. Fieldner and W. E. Rice outline the studies that were undertaken on the subjects of coal preparation and utilization.

They found that American coal can be washed efficiently to reduce the ash from 16.8 to 9.1 per cent, moisture free, and even better grades of coal, like that from the Pratt field in Alabama, can have the ash reduced from 10.3 to 7.6 per cent. These results have encouraged experimental work with flotation plants and the changes which these experiments have brought about in the characteristics of the coal indicate that actual tests in steam plants will be necessary to determine how best to use the products of modern coal refineries. Their investigations dealing with pulverized coal led them to make the statement that "Contrary to general belief the ash-bearing constituents are not always the most resistant to crushing."

Smoke abatement and fly-ash came in for extensive investigation, as might be expected, but boiler feedwater conditioning was also a subject of investigation by the Bureau of Mines which may seem to be a little off its beat. This study was found necessary due to the many Government plants throughout the country.

◆ **RESEARCH . . .** Industrial concerns and engineering societies are also carrying on a vast amount of research work. True, they interest themselves in subjects that have possibilities of developing into commercially usable ideas, nevertheless most of our fundamental discoveries in science of recent years have come out of industrial laboratories or those supported in part by private contributions.

Just recently the Engineering Foundation issued its annual report indicating the expenditure of some $40,000 for research on fifteen projects which involved thirty-two subjects. The sum spent by the Foundation, however, does not represent the entire amount spent on projects it sponsors. As a matter of policy it aids in originating, organizing, financing, and following through technical and other projects of broad interest which are within its scope, and which are not likely to be undertaken by other agencies. It is a co-operative organization which neither owns nor manages laboratories, but depends principally upon colleges, universities and government bureaus to carry the project through to conclusions. Research, however, is never really ended, it may be stopped for a time, but if properly recorded, unknown factors will have presented themselves and future investigators will turn their attention to the loose ends in the hope of adding to the store of authentic data.

At Purdue, for example, investigators started work years ago on critical pressure steam boilers. Pressures and temperatures and steels to withstand them made a full sized objective. Water circulation and feedwater control became problems demanding attention. During the past year the viscosity of steam at high pressure and temperature has been carefully studied and corrosion of boiler metals under these extreme conditions is being investigated intensively.

◆ **SMASHED ATOMS . . .** Plans for scientific work to be conducted by the Westinghouse Company during this year have recently been announced by the director, Dr. E. U. Condon. Naturally the national defense program will take precedence over other research work. Physicists, chemists, biologists, medical scientists, all types of scientific experts will be engaged in this work just as are production men in factories. Nevertheless, nuclear physics or "atom smashing" will continue to receive major attention, for immediate practical uses are being found for artificial radio-active materials in chemistry and medicine. Metals, alloys for special uses, synthetic rubber and plastics are all coming in for study in the light of modern physics in which the electron microscope will have a useful service.

◆ **FROM THE NAVY . . .** Commenting on the National Defense articles in the January issue of Power Plant Engineering, Secretary of the Navy Frank Knox paid the following tribute to engineers engaged in supplying power:

"Power in terns of government may create and nurture human freedom to the ever-increasing advantage of the individual. In the same way it may create a despotism with accelerating degradation to all it touches. Power in the electrical industry has been this nation's greatest civilizing agent, benefitting the lives of every one of us. The electrical engineer can well be considered the doctor of human progress. In time of national danger his efforts turn to protecting the results he has already accomplished. The future of our country and the continued success of democratic processes depend on the co-ordinated efforts of all the people, but without electrical power our battleships could not operate, our guns fire, our communications from ship to shore be maintained. To the electrical engineer we now turn for the best he has to give, scientifically and in day to day achievement."

SMALL TURBINES

By J. D. SCHMIDT

Westinghouse Steam Division
Westinghouse Electric & Mfg. Co.
South Philadelphia, Pa.

SMALL TURBINE auxiliary drives often are the stepchildren of the plant. Many power engineers who are solicitous about the welfare and upkeep of major equipment are as indifferent as a stepfather about what happens to the auxiliaries.

There are, of course, many plants in which small units are treated with the utmost consideration, but there are still enough places where the role of the auxiliary equipment is not properly appreciated to justify a brief review of the salient features of the proper care and operation of auxiliary drives.

Most turbines used for driving auxiliaries are of the one- or two-stage impulse type. Their size, and the fact that the exhaust steam is used for feedwater heating or in some manufacturing process, make the greater complication of the multi-stage type unprofitable. Such units are commonly controlled by a simple shut-off valve and some form of centrifugal-weight governor actuating a single valve in the steam chest for speed control.

This is the simplest form of the so-called "small turbine." The line of demarcation between "small" and "large" turbines is extremely vague, but one- or two-stage impulse units can be adapted by the application of suitable governing mechanisms to a variety of applications for which the greater cost of the more efficient multi-stage turbine is not justified.

Install the Turbine Properly

Proper installation is extremely important because of the possibilities latent in it for future trouble or future satisfaction in the performance of the apparatus in service.

Especially should its importance be emphasized in the case of additional apparatus being installed in an existing plant. There is a natural reluctance to incur any avoidable alterations to existing piping and structure, and consequently steam and exhaust connections, drains, and even sometimes foundation structures, of a makeshift nature are accepted because they appear economical, though they may be recognized as fundamentally poor practice.

It should be understood that small size does not automatically confer immunity from the difficulties commonly experienced on large machines, and auxiliary drive disabilities, through resulting outage to main units, may loom large in the over-all plant operating record.

With respect to piping, two matters in particular should be watched; drainage and expansion. Do not make the auxiliary turbine a drain for the whole auxiliary steam header. The steam supply should be taken from the top of the header, not the bottom, where all the accumulated condensate could drain out into the turbine. In addition, proper provision should be made for draining the steam line ahead of the turbine inlet and such drains should be led to a point where the vapors will not be objectionable and should be controlled by a valve with the handwheel conveniently and conspicuously located and labeled.

Expansion of the steam and exhaust piping should be considered

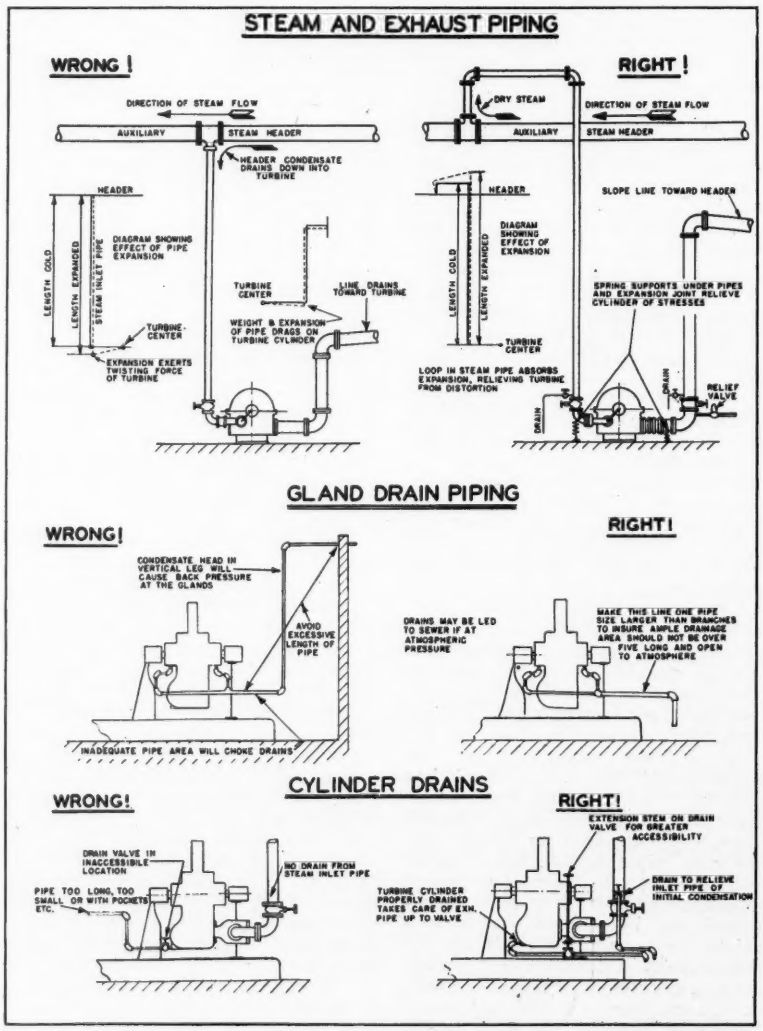

STEAM AND EXHAUST PIPING
WRONG !
RIGHT !
DIRECTION OF STEAM FLOW
AUXILIARY
STEAM HEADER
HEADER CONDENSATE DRAINS DOWN INTO TURBINE
HEADER
DIAGRAM SHOWING EFFECT OF PIPE EXPANSION
LENGTH COLD
LENGTH EXPANDED
STEAM INLET PIPE
TURBINE CENTER
EXPANSION EXERTS TWISTING FORCE OF TURBINE
LINE DRAINS TOWARD TURBINE
WEIGHT & EXPANSION OF PIPE DRAGS ON TURBINE CYLINDER
DRY STEAM
SLOPE LINE TOWARD HEADER
SPRING SUPPORTS UNDER PIPE AND EXPANSION JOINT RELIEVE CYLINDER OF STRESSES
LOOP IN STEAM PIPE ABSORBS EXPANSION, RELIEVING TURBINE FROM DISTORTION
DRAIN
RELIEF VALVE
GLAND DRAIN PIPING
WRONG!
RIGHT!
CONDENSATE HEAD IN VERTICAL LEG WILL CAUSE BACK PRESSURE AT THE GLANDS
AVOID EXCESSIVE LENGTH OF PIPE
INADEQUATE PIPE AREA WILL CHOKE DRAINS
DRAINS MAY BE LED TO SEWER IF AT ATMOSPHERIC PRESSURE
MAKE THIS LINE ONE PIPE SIZE LARGER THAN BRANCHES TO INSURE AMPLE DRAINAGE AREA SHOULD NOT BE OVER FIVE LONG AND OPEN TO ATMOSPHERE
CYLINDER DRAINS
WRONG!
RIGHT!
DRAIN VALVE IN INACCESSIBLE LOCATION
NO DRAIN FROM STEAM INLET PIPE
PIPE TOO LONG, TOO SMALL OR WITH POCKETS ETC.
EXTENSION STEM ON DRAIN VALVE FOR GREATER ACCESSIBILITY
DRAIN TO RELIEVE INLET PIPE OF INITIAL CONDENSATION
TURBINE CYLINDER PROPERLY DRAINED TAKES CARE OF EXH. PIPE UP TO VALVE

Fig. 1. Chart showing a few typical "do's" and "don'ts"

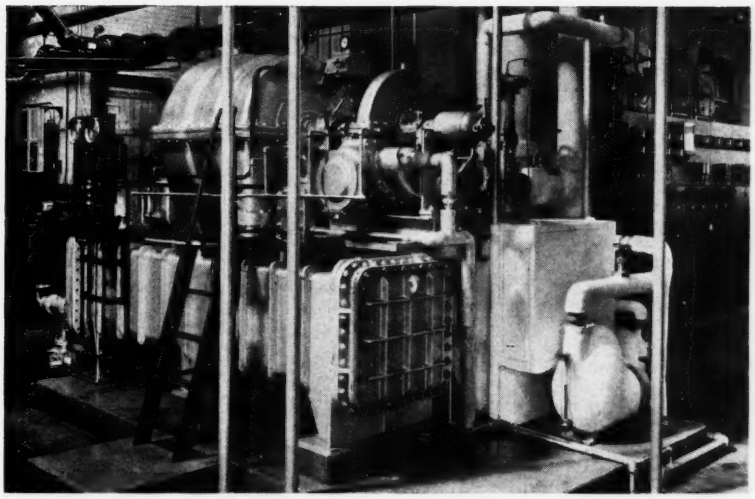


Fig. 2. Clean, sightly and accessible—a model small turbine installation

in arranging the installation. In a small single-stage or two-stage turbine, the piping is quite large in proportion to the size of the unit itself and the forces set up by the pipes in expanding may easily become a very serious matter.

The criterion of a proper arrangement is that, when heated up to normal operating temperature and unbolted from the turbine, the inlet and exhaust piping should not spring away from the turbine or out of line from it. This condition is best approximated by providing ample flexibility in the piping itself and supporting the lines close to the turbine with spring supports, so proportioned as to permit slight adjustments and yet take the weight of the piping off the turbine. The exhaust pipe should be provided with an expansion joint close to the turbine.

Drain

Next after the steam and exhaust piping, and equally important, are the cylinder and gland drains. These should be as short as is consistent with the necessity for carrying the drainage to a suitable point of discharge. They should preferably have a straight run, sloping away from the turbine, and should be of ample size. If conservation of even this small amount of water is important, the drainage should be discharged at atmospheric pressure to an open drain tank, or preferably to the sewer. Piping should be run without pockets and if several drains are joined the common pipe should be as large as or larger than the sum of the branches.

Assuming that the design of the installation layout is satisfactory, the next thing is to have the machine properly installed; that is, to see that the unit is securely bolted to the foundation, but in such manner as not to affect the alinement of the prime mover with the driven apparatus. In this connection it is well to remember that a three-point support is the ideal condition. Since three points in space determine a plane, a unit supported at three points may be shifted bodily but, since the three points will remain in the same plane, there can be no internal distortion in the structure. Nevertheless, machines are frequently supported at four points. This is, of course, quite satisfactory, provided the foundation is adequate and that the unit is properly set up in the first instance.

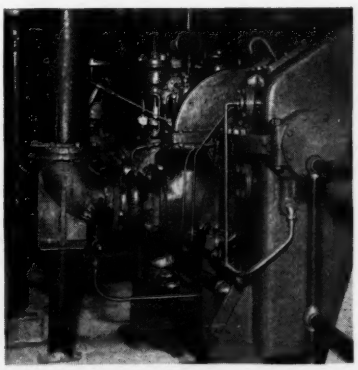


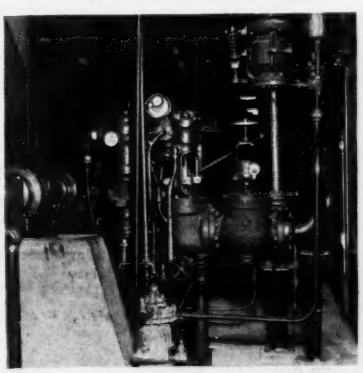
Fig. 3. (Left) Satisfactory exhaust pipe arrangement with expansion joint and supporting foot. (Right) Steam inlet piping of the same unit showing supporting foot. While satisfactory, this installation could have been improved by using spring supports of the type shown under the steam chest

In the case of pumps and the like, the prime mover and the driven unit are frequently mounted on a common bed-plate. In this case, it is usual to ship the apparatus with the coupling bolts removed from the coupling between the turbine and the driven machine and the doweling not completed. This is done to insure that a check of the alinement between the driving and driven units will be made before the apparatus is placed in operation. A reasonable amount of care exercised in checking and adjusting the alinement of the units at the time of installation will pay dividends in the form of trouble free operation.

It would seem that it should not be necessary to point out that upon receipt of the apparatus from the manufacturer, a thorough inspection should first be made to make sure that no damage has been sustained in transportation, that all protective coatings, slushing compound, etc., which may have been applied for protection in transit should be removed, and that bearing cavities, steam and exhaust openings, etc., should be examined and cleaned, if necessary, and that all steam lines are properly blown out before they are connected up and any attempt is made to operate the unit.

Common Sense Determines Good Practice

Rotative apparatus is so simple, so quiet, and normally so dependable that it is sometimes difficult to impress upon operators sufficiently the necessity for adopting a proper routine for periodic observation and care. Subordinates are apt to begrudge the time necessary to make a regular round of the auxiliary apparatus when they feel sure that they will find each machine, as usual, functioning properly without apparent need



for attention. Also, it may be said that, either through necessity or through poor plant arrangement, auxiliary units are frequently installed in relatively inaccessible locations, thus making even the minimum amount of inspection and care a drudgery.

Before starting the turbine, clean off any dirt which might have accumulated during the installation work and be sure that there is no dirt in bearing cavities or other internal parts. Be sure that the working parts of the governing mechanism are clean and in good working condition.

Be sure to place the proper amount of lubricating oil in the bearing oil ring cavities and in the oil reservoir (when a separate reservoir is used).

Check overspeed trip mechanism by means of the hand tripping device, and be sure it is working properly. Then reset it. To operate the unit, proceed as outlined in the following directions:

Detailed directions for starting, stopping and maintaining small turbines

TO START

1. Open the drains from the steam inlet and exhaust lines, and be sure these lines are free of condensate.
2. Be sure all casing drains are open.
3. Open the exhaust valve.
4. Open the throttle valve sufficiently to start the turbine rolling immediately.
5. Close the hand-controlled drains when it becomes certain that the parts which they drain are free of condensate and the turbine is heated sufficiently to prevent additional accumulation of water.
6. Open the throttle valve gradually to increase the speed. As the speed approaches normal, see that the governing valves close partly and properly control the speed. This can be seen by movement of the governing valve stems.
7. When the governor has taken control of the speed, open the throttle valve wide.

TO SHUT DOWN

1. Trip the overspeed trip by hand. This is the easiest way to stop the turbine and will test the trip mechanism. However, this tests only the trip linkage and quick closing valve and does not check the speed at which the overspeed trip weight functions.
2. Close the throttle valve.
3. Reset the overspeed trip mechanism, thus putting it in the correct position for the next starting period.
4. When the turbine comes to rest, close the exhaust valve and OPEN ALL DRAINS BETWEEN THE THROTTLE VALVE AND EXHAUST VALVE.

PRECAUTION — Keep the exhaust valve closed and all casing drains open while the turbine is shut down. This is of utmost importance to prevent the accumulation of condensate in the casing which might cause corrosion and impair the future operation.

MAINTENANCE IS SIMPLE

1. Keep the machine clean.
2. Clean the governing valve stem and throttle valve stem as often as necessary, to prevent the accumulation of boiler compound or other foreign matter. These parts must be kept working freely.
3. Keep the throttle valve in good condition and steam tight, in order to prevent leakage of steam into the turbine during shut-down periods. All drains must be kept open whenever the unit is shut down.
4. Trip the overspeed trip occasionally to see that it is in good working order.

It is a common supposition among motor car owners that as long as a car is operating satisfactorily one should let it alone. However, motor car owners are given to playing hunches, which is something that the power plant operator can ill afford to do. Therefore, motorists' evidence to the contrary notwithstanding, the wise power station operator will make it a practice, as part of his maintenance schedule, to give his small units as well as the large ones a complete inspection at least once a year. By this is meant a complete disassembly of the unit, with a thorough examination of all parts with special emphasis on those normally subject to wear.

Governor and steam chest valve parts and the overspeed trip mechanism should be carefully examined for evidences of excessive or erratic wear. If glands of the carbon ring type are used, the gland cavities and the rings should be carefully cleaned so that, when replaced, the carbon ring segments will be able to adjust themselves freely. Bearing cavities should be thoroughly cleaned to remove any sediment that may have been precipitated from the oil. It goes without saying that this is the time to replace badly worn or doubtful parts. It might be opportune at this point to mention the fact that if any unusual or abnormal condition is observed, no one would be more interested to hear about it than the manufacturer, who, after all, bases his periodical modifications of design upon the experience in the field which his customers or his own service representatives have reported.

To sum up, it is true that small turbines have been known to operate for long periods under adverse conditions, with no care or maintenance whatever, but it is nevertheless also true that the operator who takes as good care of the pumps in the basement as he does of the show piece in the turbine hall, though he will not be able to boast that he never needs to look at his turbines, will also never have to complain that they let him down in a pinch.

Gathering Data for Records

Turbines like this 35,000 kw., 3600 r.p.m. unit using steam at 900 deg. F. and 800 lb. pressure depend upon the reliability of many small turbines to keep them in service. What the thermometer tells is also important.

INSPECTION AND MAINTENANCE SYSTEM

Part I. Efficiency of operation of any plant depends on how well organized the inspection and maintenance system may be. The importance of this system varies to a great extent with the operating conditions, plant characteristics and locality and numerous other factors. Planning a proper schedule will be dealt with in this installment of a two-part series. How to carry out and check against the schedule will be treated in Part II.

By Y. C. Lu and T. Sun
Shanghai Power Co.
Shanghai, China

EACH STATION has its own difficult problem as regards its inspection and maintenance work. Some stations are located at great distances from the manufacturers of their equipment. Some stations are more or less isolated from others on the distribution side. Some stations have a part of their old equipment in a very much worn-out stage, in "danger zone" as it is called. Such conditions would undoubtedly necessitate a good inspection and maintenance system to keep the equipment in the best possible condition for service. This article will endeavor to describe the planning of a schedule for a station presumed to have all these difficulties. In addition to the conditions described above, this station is supposed to operate at two steam pressures, and contain boilers and turbines of different sizes, types and makes. The data used later are of a purely hypothetical basis.

Nevertheless, the procedure and method are presented with reference to a particular system where they have been actually practiced with success.

It is not anticipated that the readers would find all these difficulties at the same time in their stations. In presenting this system the writers have in mind that it may be simplified or modified in order to suit the conditions of central power stations according to their sizes and operating conditions. It may also serve as a reference to power plant operators as it is prepared in the spirit of scientific management, all forecast and planning being based on operating data and experience rather than the rule of thumb.

Station Capacity vs. Demand

The first step in the planning is to compare the station aggregate capacity and the estimated load demand. In this connection there are usually two sets of values to be compared. If the instantaneous peak is considered, the peak capacities of plant equipment (boilers and turbines) should be used to form the aggregate plant capacity. On the other hand, if the maximum hour generation is taken as the maximum station demand, the continuous operating capacities should be added up in order to give the total plant capacity. Operating experiences are usually the best guide to set values for the peak and continuous capacities of a unit.

TABLE I—TURBINE-GENERATORS

T No.	No. of Units	Name-plate Ratings 1000 Kw.		Peak Capacities Determined by Tests in 1000 Kw. Winter		Summer		Steam Condition	
		Each T	Each Group	Each T	Each Group	Each T	Each Group	Press. Psi	Temp. °F.
1 & 2	2	3.0	6.0	3.0	6.0	3.0	6.0	200	600
3 & 4	2	12.0	24.0	13.0	26.0	11.0	22.0	200	600
5, 6 & 7	3	15.0	45.0	16.5	49.5	14.0	42.0	200	600
8	1	20.0	20.0	21.0	21.0	18.0	18.0	200	600
9* & 10*	2	3.0	6.0	3.0	6.0	3.0	6.0	200	600
11, 12, 13	3	20.0	60.0	21.5	64.5	19.0	57.0	400	750
Total	13		161.0		173.0		151.0		

*House Turbines.

Estimation of load demand on a station belongs to another sphere of work which will not be discussed here. In the following example the predicted peak load demand curve is supposed to have been drafted by experts in the consumers or commercial departments and considered as reasonably reliable by all concerned.

This station is supposed to operate at two different pressures and consist of 21 boilers (B) and 13 turbine-generators (T) of different capacities as shown in Table I.

The name-plate rating is generally considered as the safest guide to the load that a turbine-generator

DATE (MONTH) (YEAR)	B-1							B-2						
	HOURS				CUMULATIVE OPERATING HOURS SINCE			HOURS				CUMULATIVE OPERATING HOURS SINCE		
	AVAILABLE	OPERATING	BANKING	MAINTENANCE	LAST CLEANING	JAN. 1ST.	LAST OVERHAUL	AVAILABLE	OPERATING	BANKING	MAINTENANCE	LAST CLEANING	JAN. 1ST.	LAST OVERHAUL
FORWARDED FROM LAST MO.														
SUN.														
MON.														
TUES.														
WED.														
THURS.														
FRI.														
SAT.														
TOTAL FOR WEEK														
THURS.														
FRI.														
SAT.														
TOTAL FOR WEEK														
SUN.														
MON.														
FORWARDED TO NEXT MO.														
TOTAL FOR MONTH														

Fig. 1. Boiler Service Book

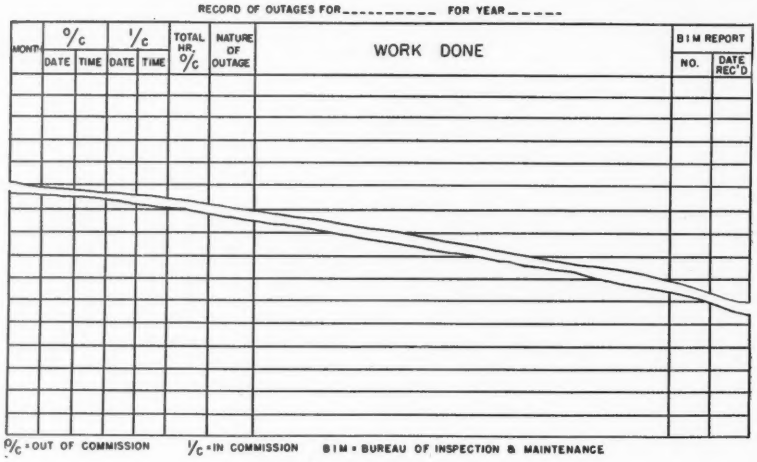
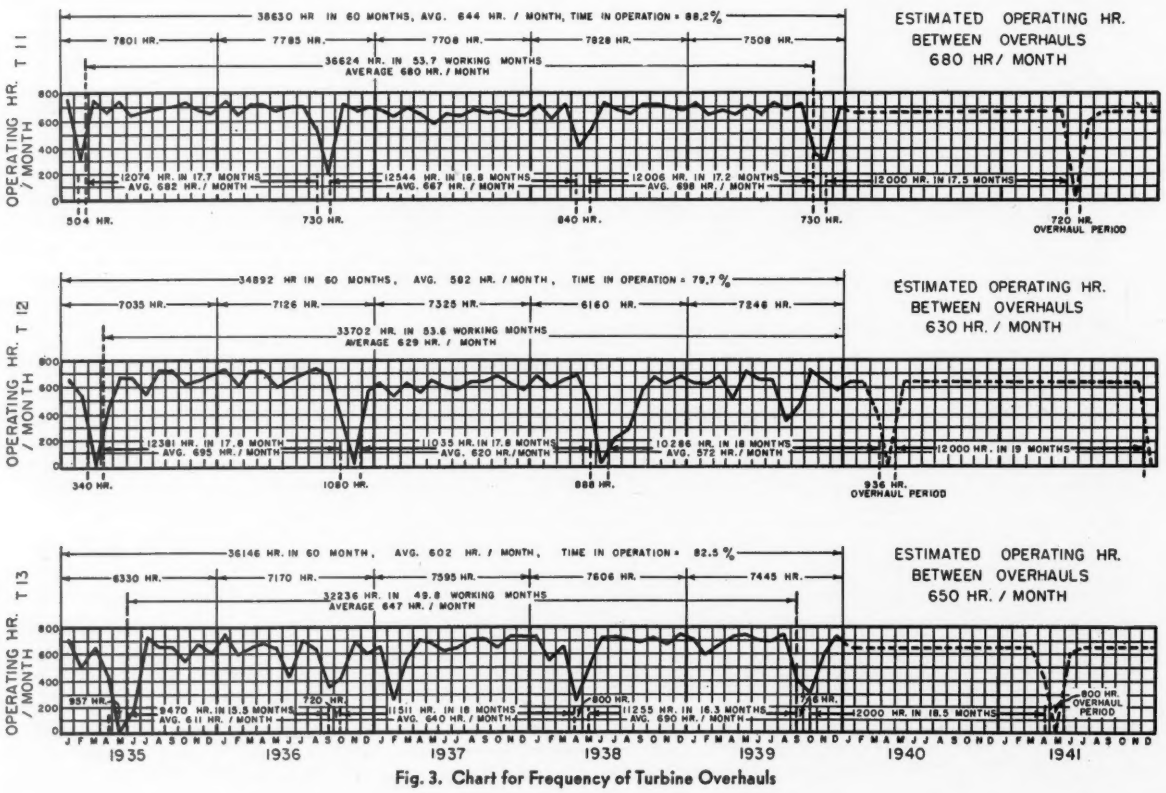


Fig. 2. Front Page of History File

can carry continuously without exceeding its mechanical and electrical limitations, provided all surrounding circumstances are within the specified conditions. Under special conditions, however, such as tropical ambient temperature during summer, or non-uniform rate of application of load for peak load machines, it is often necessary to under-load certain turbine-generators during summer months. While on the other hand when ambient temperatures are low during winter, or when another unit is out of commission during emergencies, it may be desirable to load some particular units beyond their name-plate ratings for considerable periods of time during peaks.

Thus in Table I, name-plate ratings are taken only as reference in the procedure of determining the actual peak capacity of respective turbine-generators which are obtained by tests under summer and winter local conditions. After necessary consultation with the manufacturers, logical peak ratings will be determined for turbine-generators, in excess of continuous name-plate ratings, giving an increased station capacity during winter months. Some units may be limited on the steam ends and others on the electrical ends. For those limited on electrical end, the capacities are considered to decrease as the surrounding temperature increases until the specified maximum ambient temperatures are reached when summer capacities were fixed. For those limited on steam end, capacities decrease as the steam consumption increases due to hot circulating water temperature.

According to local climate, January, February, March, and December may be taken as winter months and July, August, as well as first half of September as summer months. Turbine-generator capacities are considered to be constant throughout the respective winter and summer seasons. Capacities for the remaining months of the year varying inversely with the surrounding temperature, are determined by interpolation from capacity diagram specially prepared for respective turbine-generators. If expenses are justified, capacity tests may be carried out at different seasons of the year, but the summer and winter ratings are generally sufficient for the purpose.


38630 HR IN 60 MONTHS, AVG. 644 HR. / MONTH, TIME IN OPERATION = 88.2%
ESTIMATED OPERATING HR. BETWEEN OVERHAULS 680 HR/ MONTH
OPERATING HR. / MONTH T 11
7801 HR.
7783 HR.
7708 HR.
7828 HR.
7508 HR.
36624 HR. IN 53.7 WORKING MONTHS AVERAGE 680 HR. / MONTH
12074 HR. IN 17.7 MONTHS AVG. 682 HR. / MONTH
12544 HR. IN 18.8 MONTHS AVG. 667 HR. / MONTH
12006 HR. IN 17.2 MONTHS AVG. 698 HR. / MONTH
12000 HR. IN 17.5 MONTHS
504 HR.
730 HR.
840 HR.
730 HR.
720 HR. OVERHAUL PERIOD
34892 HR IN 60 MONTHS, AVG. 582 HR. / MONTH, TIME IN OPERATION = 79.7 %
ESTIMATED OPERATING HR. BETWEEN OVERHAULS 630 HR. / MONTH
OPERATING HR. T 12 / MONTH
7035 HR.
7126 HR.
7325 HR.
6160 HR.
7246 HR.
33702 HR. IN 53.6 WORKING MONTHS AVERAGE 629 HR. / MONTH
12381 HR. IN 17.8 MONTH AVG. 695 HR. / MONTH
11035 HR. IN 17.8 MONTHS AVG. 620 HR. / MONTH
10286 HR. IN 18 MONTHS AVG. 572 HR. / MONTH
12000 HR. IN 19 MONTHS
340 HR.
1080 HR.
888 HR.
936 HR. OVERHAUL PERIOD
36146 HR. IN 60 MONTH, AVG. 602 HR. / MONTH, TIME IN OPERATION = 82.5 %
ESTIMATED OPERATING HR. BETWEEN OVERHAULS 650 HR. / MONTH
OPERATING HR. T 13 / MONTH
8330 HR.
7170 HR.
7595 HR.
7606 HR.
7445 HR.
32236 HR. IN 49.8 WORKING MONTHS AVERAGE 647 HR. / MONTH
957 HR.
9470 HR. IN 15.5 MONTHS AVG. 611 HR. / MONTH
720 HR.
11511 HR. IN 18 MONTHS AVG. 640 HR. / MONTH
800 HR.
11255 HR. IN 16.3 MONTHS AVG. 690 HR. / MONTH
176 HR.
12000 HR. IN 18.5 MONTHS
800 HR. OVERHAUL PERIOD
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1935
1936
1937
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1939
1940
1941

Fig. 3. Chart for Frequency of Turbine Overhauls

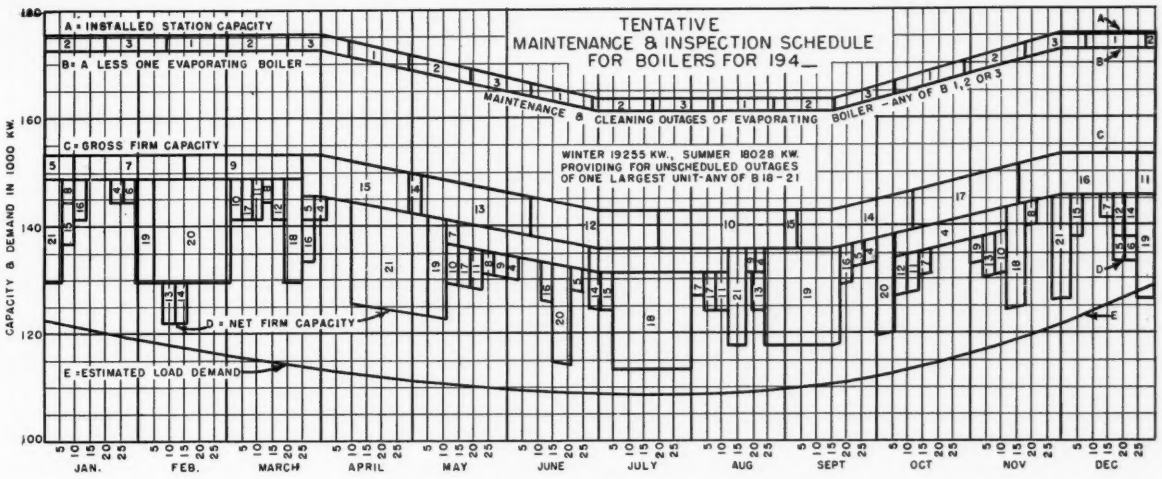


Fig. 4. Maintenance and Inspection Schedule for Boilers

In order to make easy comparison with station load demand, capacities of turbine-generators are rated in kilowatts (instead of kv-a.) at a specified average station power factor. Summation of kilowatt ratings of all turbine-generators during winter and summer months are used as installed peak capacity for respective months.

Experience has enabled power plant operators to eliminate the necessity of constantly revising the steam demand curve by rating the boilers in equivalent kilowatts instead of pounds of steam generated per hour which was at one time considered as the natural way of expressing the capacity of a boiler. With boilers rated in pounds steam per hour, the station demand in kilowatts must first be converted into pounds steam required per hour in order to compare with available boiler capacities.

For a station consisting of turbines of similar sizes and makes, and therefore the same steam consumption rates, it makes little difference which method should be adopted. But for a station with more than one steam pressure, the high pressure turbines usually have better steam rates than the low pressure units and if one of the high pressure turbines is out of service, the boiler house would vary according to whether or not any important turbine is in operation. In other plants, the steam demand curve on the boiler maintenance schedule would be dependent on the turbine maintenance chart for its applicability, which is certainly a great inconvenience.

So in Table II the boiler capacity is reduced to equivalent kilowatt capacity which can easily be compared with the kilowatt station demand. The summation of these equivalent capacities for all the boilers during winter or summer months is taken as the installed boiler capacity for the station for the respective season.

Operating and Maintenance Record

From station logs (kept by operating staff) daily operating and maintenance hours will be recorded in service books for respective main units. Figure 1 shows an example of boiler service book which gives operation of each boiler during the month together with cumulative steaming hours since last cleaning or overhaul. The first column under each boiler—"Available Hours"—means total time available for service no matter whether it is steaming, banking or or is in standby condition. Similar service record is kept for each turbine-generator, with the column "banking" omitted.

For equipment put back into service after maintenance, an inspection report is prepared by Maintenance Department (Electrical or Mechanical) and signed by the engineer making the inspection. From these reports, necessary data are taken to make out the history file of each main unit. Figure 2 shows a front page of a history file, which replaces the old record card system and also serves as an index for the inspection reports, in case any detail information is required.

The service book is useful as a basis to forecast "frequency of routine inspection." For equipment which is not frequently operated such as sump pumps, d.c. engine-generator set (for magnetizing turbine rotor in magna-flux tests), etc., the frequency of inspection is on "time-elapsed" basis, say once every 12 months or once every 16 months. For the frequency operated equipment such as turbines, boilers and boiler feed pumps, the frequency is on "operating hour" basis and the service book is most useful in this regard. This can best be illustrated by an example. Take No. 13 turbine-generator. From past record it is known that the routine inspections should be after 950 operating hours and general overhauls after 12,000 operating hours. From the service book, the actual operating hours for this generator for each month is plotted and together with data for other generators is shown on Fig. 3. From the figure it is noted that for the period that the machine is operating, the average operating hours per month is 650. Thus in

TABLE II—BOILERS

B No.	No. of Units	Rated Capacity 1000 lb. steam/hr.		Peak Capacities in Equivalent Kw. Winter		Peak Capacities in Equivalent Kw. Summer		Steam Condition	
		Each B	Each Group	Each B	Each Group	Each B	Each Group	Press. Psi	Temp. °F.
1— 3	3	40.0	120.0	3,080	9,240	2,860	8,580	200	600
4— 9	6	60.0	360.0	4,620	27,720	4,300	25,800	200	600
10—17	8	100.0	800.0	7,700	61,600	7,140	57,120	200	600
18—21	4	200.0	800.0	19,255	77,020	18,028	72,112	400	600
Total	21		2080.0		175,580		163,612		

B1-3 are supposed to be boilers for evaporating make-up water.

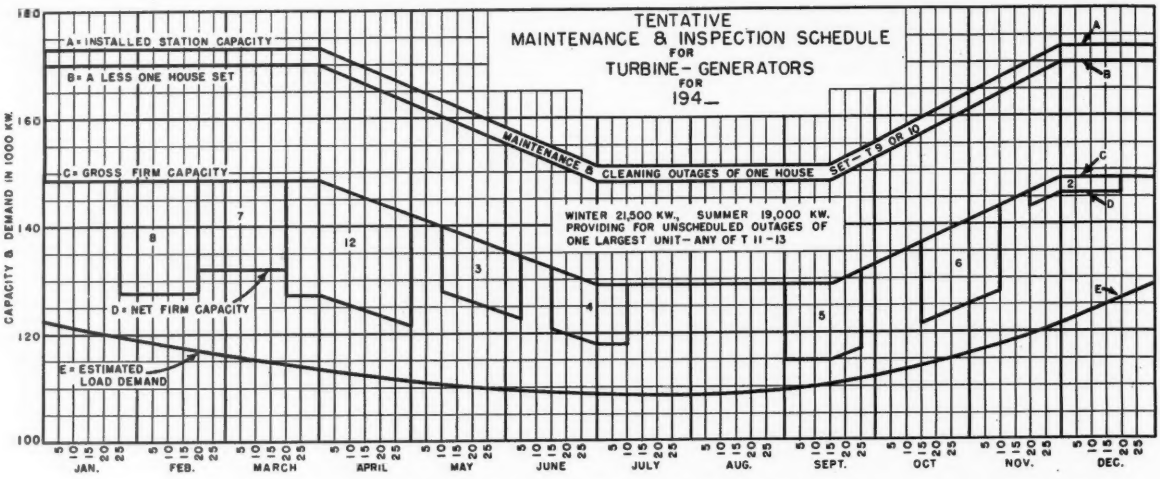


Fig. 5. Maintenance and Inspection Schedule for Turbine Generators

the maintenance schedule the time laid out for this generator is $950 \div 650$ or approximately $1\frac{1}{2}$ months between two routine inspections and $12{,}000 \div 650$ or $18\frac{1}{2}$ months between overhauls.

So from the service book we determine the operating hours and elapsed time before each piece of equipment is taken out for inspection, and from the history file we determine the time required for each type of inspection and maintenance work.

The above method and procedure may appear to be too elaborate and expensive, but for a station composed of various types of equipment, this is the safeguard against any slip in memory and misjudgment. And for a well planned maintenance schedule, these data are indispensable.

Planning of Inspection and Maintenance Schedule

Scheduled inspections of main units are shown in Fig. 4 and 5 (similar charts may be prepared for plant auxiliaries).

For each chart the station capacity is plotted at the top (Curve A) and the estimated load demand at the bottom (Curve E). The difference between these two curves appears to be the station surplus capacity, which can be taken out for maintenance work. In many stations the situation is not so simple.

For example, one house turbine (T 9 or 10), of the station in question, has to be kept as spare for the other one in operation. A capacity equal to one of the biggest turbines should be provided against any unscheduled outage of one large base load turbine or equivalent in small units. The remaining capacity is designated as "gross firm capacity," which is represented by Curve C in Fig. 5.

Similarly on the boiler chart (Fig. 4) one small boiler (any of B 1, 2, 3) which is always out for cleaning after evaporating raw town water together with one of the largest boilers, are to be deducted from the station capacity Curve A to obtain the gross firm capacity C.

The difference between the station gross firm capacity and estimated load demand is then the actual available capacity that can be spared for maintenance. In this available space on the chart, the units to be spared for inspection and maintenance are designated, based on the proper operating and maintenance hours which have been gathered from the service books and history files. Unless an abnormal condition arises, the time of each unit to be put in operation or in maintenance should be followed as closely as possible. Thus the schedules laid out ahead of time are ready to be put into operation.

Some system is better than no system and a simple system that can be followed easily and closely is much better than a complicated one that would incur unnecessary expenses and arouse undue reaction among plant workers. A preliminary schedule should be set up for any station as a trial and extended or modified later as justified by expenses and other circumstances. But any addition or modification of the existing routine should be carefully explained to all men concerned, to make them fully realize the reasons and advantages of such changes. Thus co-operation will be assured.

Any change should be best supported by statistical data which is the most convincing argument to the management as well as to the plant workers. The service book and history file may take a few years to compile, yet they will be very convenient at times as a check of the performance of plant equipment.

(To be continued.)

WELDING PROCESS

A WELDING process which has received wide recognition in industrial construction has been developed jointly by engineers of the Public Service Electric and Gas Company, Newark, and the United Engineers & Constructors, Inc., Philadelphia, and manufactured by Electric Arc Cutting & Welding Company of Newark.

Known to the trade as preheating-welding-normalizing, the development consists of inductively heating high-pressure pipe before and during welding, and treating it after welding. Its advantages are: (1) its adaptability for use on irregular objects, (2) its ruggedness, and (3) the safety with which it can be used. For their work on this and other welding developments, George Dolan and Harry B. Smith of the United Engineers and Claude J. Holslag of Electric Arc were given a plaque by the Nat' nal Association of Manufacturers.

EQUIVALENT SURFACE AREAS

Part I. An introduction to a new method of comparing boiler performance

By G. CAMPBELL KOHLAR

JOE IS THE ENGINEER of a small manufacturing plant. Business is picking up and he knows that before long he will need another boiler. What to suggest to the boss when that time comes? There's his friend, Tom. His boss is a nut on efficiency, and they have a new four-drum boiler with an economizer and an air heater over at that plant. It is fired by pulverized coal and they are getting 86 per cent efficiency. Then there's Dick. His plant has just acquired a new boiler, one of these new fangled two-drum affairs with oil burners, waterwalls, 'n' everything. They get close to 80 per cent over there. And good old Harry. His plant has a new boiler, too. Harry has a chain grate fired, straight-tube boiler like he's been operating for years—and he swears by it. Well, what to suggest to the boss when the time comes?

Joe has quite a problem on his hands. Being a smart engineer, he realizes that efficiencies and ordinary heat balances do not tell the whole story. He knows that 90 per cent efficiency is not impossible, but he also knows that the cost of getting that kind of efficiency could never be made up in operation. He knows that an air heater on Harry's chain grate boiler would raise the efficiency four or five per cent, but the cheap coal they burn on that stoker would not justify the added investment. How can Joe make a reasonable comparison of these different boilers?

The lately developed Equivalent Surface Area (E. S. A.) method of comparing boilers of various types and sizes, or similar boilers under widely varying conditions, will be of great help to many Joes in selecting the right boiler for their purposes. It is a method that reduces all boilers to a common basis for easy comparison in much the same way in which horsepower reduces all motors and engines to a common basis.

Every engineer is familiar with the formula, HP = PLAN ÷ 33,000. By this means an engine with a 6 in. stroke and a 4 in. bore can readily be compared with one having a 20 in. stroke and a 12 in. bore. A 2000 r.p.m. internal combustion engine can easily be compared with a 60 r.p.m. steam engine. Even steam turbines and electric motors can be covered by this method. The magic "33,000" makes all prime movers equal. It is entirely an arbitrary figure, and it might just as well have been 100,000 ft. lb. per min. as 33,000. The Equivalent Surface Area method makes use of a similar device to transform all boilers into a boiler having a heat input of 500,000,000 B.t.u per hr.

All the classical definitions tell us that a boiler is a closed vessel, the function of which is to transform the chemical energy of the fuel into energy available in a more useful form. It performs this function by absorbing the heat of combustion and storing it as steam under pressure. Thus, it was early recognized that the most important characteristics of any boiler were: the heat it absorbed; and, the distribution of the heat absorbing surfaces. Boilers once were rated—and still are!—in "Boiler Horsepower," which is essentially a *definite quantity of heat absorbed per square foot of heating surface.*

Furnaces were compared or rated by B.t.u. per cubic foot of volume or B.t.u. per foot of width. In some of the modern boilers there is no "boiler heating surface" as such, and in many others the heat absorbed in the boiler proper is only a small fraction of the total heat absorbed. In the same manner, B.t.u. per cubic foot of furnace volume may be identical in two different furnaces, but each

[1]EDITOR'S NOTE: The author wishes to emphasize that this article explains only the elementary principles of the E. S. A. Diagram. Those readers who are interested in a more detailed and technical discussion of this method are referred to "Steam-Boiler Performance and a Method of Comparison," by E. G. Bailey, which appeared in the July 1940 Transactions of the A.S.M.E. Most of the data used in this article have been taken from that paper.

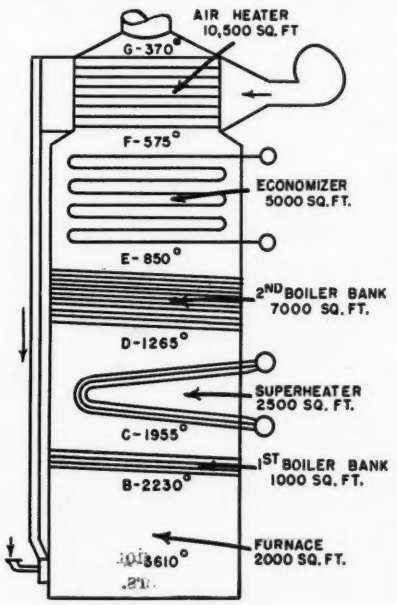
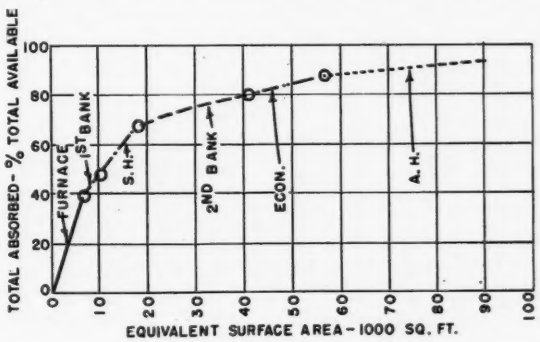


Fig. 1. Schematic diagram of a boiler and (right) the corresponding E. S. A. Diagram. Test Data for calculating the curve are given by Table I



furnace will act quite differently, according to its size and the disposition of the heating surface within it. These methods are outmoded, and a new and workable basis of comparison is needed.

Just as James Watt compared all steam engines with a unit engine capable of doing 33,000 foot pounds of work in a minute, so the Equivalent Surface Area (E. S. A.) method compares all boilers with a boiler which has an input of 500,000,000 B.t.u. per hr. Nobody cares what the size of the unit steam engine may be as long as it does the required work, and nobody cares about the size of the unit boiler as long as it has the required input. Since heat absorbed per square foot of surface is the important index, a heating surface is arbitrarily assigned to this boiler such that the heat available per square foot of heating surface—boiler, superheater, economizer, and air heater—is the same for the unit boiler and the one with which it is to be compared. This arbitrarily assigned heating surface is called the Equivalent Surface Area (E. S. A.).

Suppose for example, that a steam generating unit has a total heating surface of 25,000 sq. ft. and an available heat input of 125,000,000 B.t.u. per hr. The heat available per square foot of heating surface would then be

$$\frac{125{,}000{,}000}{25{,}000} = 5{,}000 \text{ B.t.u. per sq. ft.}$$

The standard boiler has an available heat input of 500,000,000 B.t.u. per hr., and in order to compare it with the given boiler, enough heating surface must be assigned so that the B.t.u. per sq. ft. will be 5,000. Thus

$$\frac{500{,}000{,}000}{\text{E. S. A.}} = 5{,}000;$$

$$\text{and E. S. A.} = \frac{500{,}000{,}000}{5{,}000} = 100{,}000.$$

The given boiler of 25,000 sq. ft. is therefore comparable to a standard boiler of 100,000 sq. ft.; or the given boiler has an Equivalent Surface Area of 100,000 sq. ft. The E. S. A. of any boiler, then, readily may be found from the simple relation

$$\frac{500{,}000{,}000}{\text{E. S. A.}} = \frac{\text{B.t.u. Available}}{\text{Heating Surface}};$$

$$\text{or E. S. A.} = 500{,}000{,}000 \times \frac{\text{Heating Surface}}{\text{B.t.u. Available}}.$$

This also may be written,

$$\text{E. S. A.} = 500{,}000{,}000 \times \frac{1}{\dfrac{\text{B.t.u. Available}}{\text{Heating Surface}}}$$

or the Equivalent Surface Area is inversely proportional to the B.t.u. available per square foot of heating surface.

At this point it might be well to describe briefly the method by which B.t.u. available per square foot is determined. The total heat available is the heat from the fuel that is actually burned, plus the heat in the preheated air above 80 deg. F., minus the latent heat in the moisture from the fuel and from the burning of the hydrogen. The weight of the flue gas is determined by any of the standard methods. By means of an instrument known as a high velocity thermocouple (HVT), gas temperatures are taken at various points through the unit.

For example, the temperature of the gas leaving the furnace and entering the boiler tube bank is obtained. From this temperature, the weight of the gas, and the specific heat of the gas, the total heat in the flue gas entering the boiler tubes can be computed. The difference between the heat in the gases leaving the furnace and the total heat available must have been absorbed in the furnace. This process is continued through the unit, that is, temperatures are taken before and after the superheater, economizer, etc., and the heat absorbed in each section of the unit is obtained.

The per cent of the total heat available that any section, or combination of sections, in the unit has absorbed may then be determined, and this heat absorbed, expressed as per cent of the total heat available, is then plotted against Equivalent Surface Area.

A schematic diagram of a boiler is shown in Fig. 1A, and Table I lists the necessary data for the construction of an E. S. A. diagram. The gas weight as calculated from the weight of the fuel burned and an Orsat analysis at Point B is 150,000 lb. per hr. The temperature at Point B as determined by the HVT is 2230 deg. F., and the adiabatic temperature is 3610 deg. F. If the specific heat of the gas between 3610 and 2230 is 0.30, then the heat absorbed in the furnace is

$$\text{Heat Absorbed} = 150{,}000 \times 0.30 \times (3610 - 2230) = 62 \times 10^6 \text{ B.t.u.,}$$

$$\text{and } \frac{\text{Heat Absorbed}}{\text{Heat Available}} \times 100 = \frac{62 \times 10^6}{155 \times 10^6} \times 100 = 40\%.$$

The E. S. A. of the furnace is found from the equation

$$\frac{500 \times 10^6}{\text{E. S. A.}} = \frac{62 \times 10^6}{2000};$$

or the E. S. A. = 6450 sq. ft.

Now consider the convection bank before the superheater. It will be assumed for simplicity of computation that there is no infiltration, and that the gas weight and the specific heat of the gas, which actually varies with the temperature range, are constant. The temperature at Point C is

Table I. Test data used for calculating the E. S. A. Diagram shown by Fig. 1

Gas Weight, Lb. per Hr.	150,000
Heat from Fuel—B.t.u. per Hr.	151,000,000
Total Losses (Moisture and Carbon)—B.t.u. per Hr.	8,000,000
Heat in Preheated Air, B.t.u. per Hr.	12,000,000
Total Heat Available, B.t.u. per Hr.	155,000,000

Section	A	B-C	C-D	D-E	E-F	F-G
Temp. Entering, deg. F.	3610	2230	1955	1265	850	575[1]
Heat Abs., Ind., B.t.u. per Hr. $\times 10^6$	62.0	12.4	31.0	18.6	12.4	9.3
Cum., B.t.u. per Hr. $\times 10^6$	62.0	74.4	105.4	124.0	136.4	145.7
Ind., % of Total	40	8	20	12	8	6
Cum., % of Total	40	48	68	80	88	94
Heat Ava., Ent., B.t.u. per Hr. $\times 10^6$	155.0	93.0	80.6	49.6	31.0	18.6
Heat Abs., Ind., B.t.u. per Sq. Ft.	31,000	12,400	12,400	2660	2480	875
Cum., B.t.u. per Sq. Ft.	31,000	24,700	19,200	9900	7800	5200
E. S. A.	6450	9675	17,800	40,300	56,500	90,100

[1]Temperature leaving G—370 deg. F.

measured as 1955 deg. F., and Heat Absorbed, (B-C)

$$= 150{,}000 \times 0.30 \times (2230 - 1955)$$
$$= 12.4 \times 10^6,$$

and $$\frac{\text{Heat Absorbed}}{\text{Heat Available}} \times 100$$

$$= \frac{12.4 \times 10^6}{155.0 \times 10^6} \times 100 = 8\%.$$

The E. S. A. of the boiler bank is

$$500 \times 10^6 \times \frac{1000}{155.0 \times 10^6} = 3225.$$

The E. S. A. of the furnace and the boiler bank is the sum of the individual E. S. A.'s, or 9675. This procedure is continued successively through the unit, and the results plotted as in Fig. 1-B.

(To be continued.)

DIESEL SUPPLIES ALL FACTORY POWER

A 150 hp. Diesel engine driving an a.c. and a d.c. generator 24 hr. a day, 7 days a week, serves all requirements of a storage battery factory, and has brought sufficient savings to pay for the power plant in four years

By William H. Gottlieb

OPERATING its Diesel engine continuously day and night throughout the year, Carlile & Doughty, Inc., manufacturer of storage batteries at Conshohocken, Pa., has been able to supply all plant electricity requirements at a sufficient saving to pay the entire cost of the power plant, $10,150, in approximately four years. The engine, a four-cylinder unit developing 150 hp. at 400 r.p.m., was installed in December, 1936, and put into continuous operation on January 11, 1937. Since that day, the Diesel has been running and pulling its load 32,725 hr.

The engine is stopped only once a year for the annual overhauling. At that time, the management puts half a dozen men to work, takes the engine down completely and makes sure that it is in perfect condition for another year's work. The overhaul in October, 1940, took exactly 34 hr. to complete. These were the only hours in 1940 that the Diesel was not in operation. The company's engineers have calculated that the cost of labor and shutdown are greater than the cost of minor engine parts and so it is the practice to replace any part if there is doubt of its ability to stand a full year's work. The company replaces all piston rings once a year as an insurance measure regardless of their condition.

Carlile & Doughty is certain that the expenditure of somewhat greater sums than necessary for maintenance has resulted in an eventual saving to the company. Undoubtedly, the care given the power plant is in part responsible for the fact that there has never been a breakdown. So confident is the company of the dependability of its power system, that executives have made no arrangement for standby service. It is also thought that careful maintenance has brought greater savings in other operating costs.

Fuel has given a return of 11 kw-hr. per gallon consumed. A gallon of lubricating oil serves for more than 2900 hp-hr.

Before installation of the Diesel, alternating current cost 1.17 cents per kw-hr. More than 90 per cent of the load is direct current, utilized for charging the storage batteries. Figuring the conversion losses, the cost of power came to 1.31 cents per kw-hr. Figuring all operating costs, including depreciation, the cost of Diesel-generated power totals 0.841 cents, less than eight and a half mills per kw-hr. The totals of expenditures for power plant operation in 1939 were as follows:

Fuel	$1984.07
Lubricating oil	170.45
Labor (operation, maintenance and repairs)	664.44
Materials (maintenance and repairs)	497.09
Total operating cost	$3316.05
Depreciation (on 15-year basis)	676.68
Total	$3992.73

It should be noted that the repair cost included a new set of main drive belts at a material cost of $240.

In the interest of economy and efficiency, the power plant has been made as automatic as practicable. Except during the annual

Fig. 1. One 150 hp. Diesel furnishes all light and power for this factory at Conshohocken, Pa.

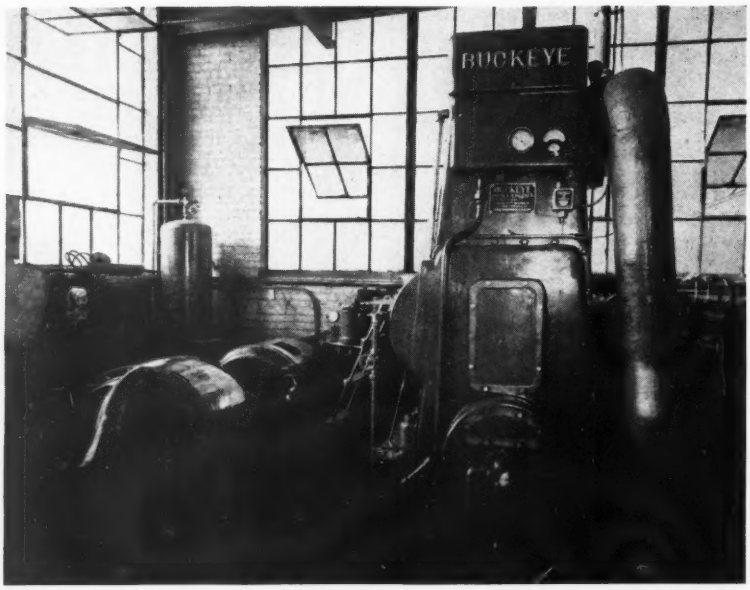


Fig. 2. Diesel driving an a.c. and a d.c. generator. View shows lubricating oil filter and tank for starting air

overhaul period, only one operator cares for the Diesel, and he spends approximately one hour a day checking and servicing the power system. The rest of his time is occupied with other duties for the company in his capacity as plant foreman.

All engines of this make are fitted with a patented safety device known as the "Silent Watchman" which shuts down the engine automatically if there is a dangerous drop in lubricating oil pressure or cooling water pressure. Carlile & Doughty supplements this safety system with two additional instruments that sound an alarm if cooling water temperature exceeds 130 deg. or if exhaust temperature goes above 700 deg.

The engine is arranged for air starting and a motor-driven compressor has been provided to supply the air. The company already had an extensive switchboard and merely added the voltage regulator and other instruments required by the Diesel.

Since direct current is needed for battery charging and alternating current for running plant motors, the Diesel is arranged to supply both requirements. A 70 kw. d.c. generator and a 50 kv-a. a.c. generator (converted from a synchronous motor) are mounted on the same shaft which is belted to the engine. A small exciter also is belted to the end of the shaft. An indication of machinery's length of life in this plant is the fact that the makeshift a.c. generator has been in service day and night for 17 yr.

The 12,000 gal. fuel storage tank is located above ground outside the plant; the 275 gal. day tank is underground. Obviously, it would be possible to transfer fuel oil from storage to the day tank by gravity, but this would create the danger of overflow and would entail higher insurance costs. In consequence, it was found economical to install a pressure valve in the line between the tanks and a motor-driven pump to transfer fuel to the day tank against the valve's 10 lb. pressure. A float has been rigged in the day tank so that it starts the transfer pump whenever the level of fuel drops below a predetermined point. All fuel is passed through a meter. A screen filter is used to remove impurities.

From the day tank, fuel is drawn by an engine-driven pump to an auxiliary fuel tank on the governor end of the engine. From this point it travels through a header extending the length of the engine with branch lines supplying individual injection pumps for each cylinder. Return lines from the auxiliary tank and the pump housings carry any excess fuel back to the day tank. Fuel is injected directly into the cylinder through differential spray valves. Carlile & Doughty does not attempt to economize on quality of fuel oil, preferring to use a high grade.

The pressure lubrication system also operates automatically. A pump driven from the end of the crankshaft takes lubricating oil from a sump below floor level at the governor end of the engine and sends it through the oil cooler on the engine into a header. From this pressure header, the lubricant flows through lines to each main bearing, through drilled passages to the crankpins, and through tubes to the wristpins. Cylinders are also lubricated by the pressure system.

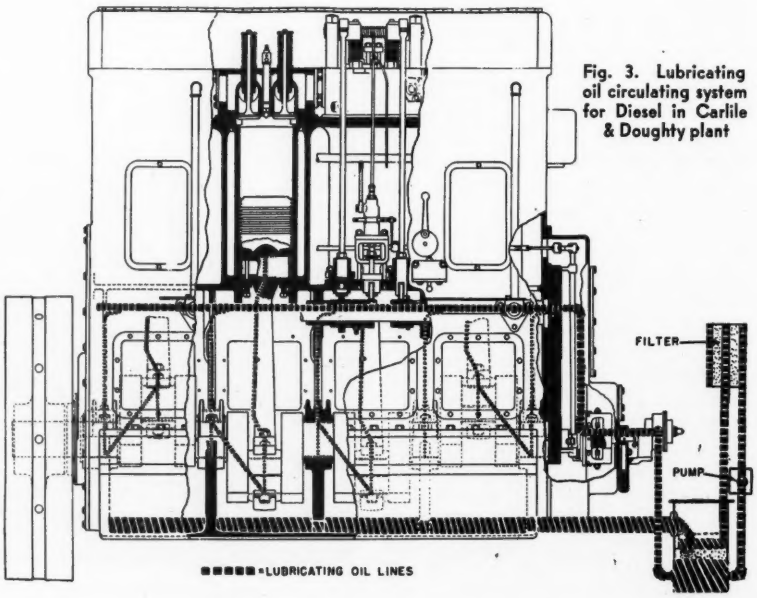


Fig. 3. Lubricating oil circulating system for Diesel in Carlile & Doughty plant

Lubricating oil drains into the crankcase and flows to the sump where it passes through a filter before it again reaches the pump suction. The plant also has an additional purification system. A motor-driven pump takes oil from the sump, puts it through a cartridge-type filter and then returns it to the sump. A pressure gage gives indication of the filter's degree of saturation and a bypass line is provided for the occasions when the filter element gets dirty and pressure drop is too great.

An open cooling system is employed with city water used for make-up. The water enters the engine through the oil cooler, then passes through the cylinder jackets and the cylinder-head jackets before leaving the engine through a jacket around the exhaust header. The hot water is cooled by means of an atmospheric-type cooling tower outside the plant. Water is circulated through this system by a motor-driven centrifugal pump located inside the plant.

Exhaust gases enter a header and are carried to an exhaust pot buried outside. Exhaust of each cylinder is measured by a pyrometer with selector switch.

The Carlile & Doughty formula for power savings appears to be: 1. A good load factor. They manage to keep the Diesel 75 per cent loaded. 2. Long, steady operation of equipment. 3. Careful maintenance of good equipment to keep it at peak efficiency. The company's cash book attests to the success of this program.

CARLILE & DOUGHTY, INC. LIST OF PRINCIPAL EQUIPMENT

Engine	One 150 hp., 4 cycle, 4 cylinder, 400 r.p.m. Diesel; Buckeye Machine Co.
Generator	One 70 kw., 125 v., d.c. generator and One 50 kv-a., a.c. generator; Crocker-Wheeler Co.
Fuel System	
Fuel oil	Sun Oil Co.
Storage tank	12,000 gal.
Day tank	One 275 gal.
Fuel meter	Trident; Neptune Meter Co.
Transfer pump	Viking Pump Co. driven by Century motor.
Injection pumps	American Bosch Corp.
Lubrication System	
Lubricating oil	Solnus. Sun Oil Co.
Lubricating oil filter	Commercial Filters Corp.
Cooling water pump	Goulds Pumps, Inc.
Pyrometer	Alnor, Illinois Testing Lab. Inc.
Alarm System	Minneapolis-Honeywell Regulator Co.
Starting Air Compressor	Curtis Pneumatic Machinery Co., belted to Crocker-Wheeler motor.
Pressure Gages	U. S. Gauge Co.

DIESEL LUBRICATION FOR SEVERE DUTY

By J. G. McNAB, W. C. WINNING, B. G. BALDWIN and F. L. MILLER[1]

DIESEL ENGINES differ considerably among themselves in the burdens they impose upon the lubricating oil and consequently in the lubrication problems they raise. Differences in design, which result in significant differences in heat flow and distribution in the engine, may cause emphasis to be placed in some cases on such problems as ring sticking, wear, and piston scuffing, and in other cases on sludge formation, varnish, coking, etc.

In general, all Diesel engines are characterized by certain features from a lubrication standpoint which set them apart from gasoline engines and make them subject to consideration on a separate and distinct basis. Taken as a class, they are (1) more subject to ring sticking, (2) form greater quantities of sludge, and (3) are subject to somewhat higher than normal rates of wear. Bearing corrosion should perhaps be included as a fourth problem, since many Diesel engines are equipped with special alloy bearings, which are subject to chemical attack should the oil oxidize too rapidly or become contaminated with corrosive materials from any source.

The ring sticking problem, which may be due either to varnish formation or to accumulation of deposits in the ring zone, is perhaps the most troublesome of the Diesel engine lubrication problems. It apparently occurs more frequently with the better refined paraffinic-type oils than with any others. Sludge formation, or separation of sludge deposits in the crankcase and on the filters, however, is probably almost equally a problem. The amount of sludge is generally less with the well refined paraffinic oils, but is still considerable. Wear is perhaps not so common to all types of Diesels, but it is more pronounced than with gasoline engines, and is more often noticed with oils of the naphthenic type.

Sludge

Chemical analyses show that the Diesel engine sludge deposits usually differ significantly from those found in the gasoline engine. Typical analyses of representative filter deposits, taken from the two types of engines operating under approximately the same conditions, show that the Diesel insoluble material has a high carbon content and a carbon/hydrogen weight ratio of approximately 50/1, whereas the sludge from the gasoline engine has a lower carbon content and a much lower carbon/hydrogen weight ratio of approximately 10/1. The ash content of the Diesel engine deposits is also much lower. It would appear that the deposits from the Diesel are mostly of a sootlike nature, and that they originated largely in the combustion chamber, rather than in oxidation of the oil in the crankcase.

Quantities of sludge which are formed and find their way into the crankcase vary considerably from engine to engine, apparently because of differences in engine, particularly combustion chamber, design. For any given set of speed, load, or other similar operating conditions, they may be relatively light in some engines and extremely heavy in others, but in any case they are normally considerably heavier than those obtained in gasoline engines operating under approximately the same general conditions.

[1]All authors are with the Esso Laboratories, Research Div., Standard Oil Development Co. This article is an abstract of a paper presented before the last Annual Meeting of the S. A. E., discussing in detail, tests made with a large number of oils on three of the better known makes of commercial Diesel engines. Because of the great amount of technical detail and data, discussion of the tests has been largely omitted and the article confined to a statement of the problem and general conclusions dealing with the practical problem of using the newer oils.

While judicious selection of the mineral oil lubricants for particular engines has made reasonably satisfactory operation possible under the milder conditions, and while some have actually been noticeably superior to others, it is rather widely conceded at the present time that only certain specially compounded lubricants have thus far been really satisfactory under the severe duty operation conditions.

Additive Compounds

Additive compounds which have been employed in the manufacture of these new lubricants are of various types, termed "inhibitors," "dispersers," and "detergents." The term detergent normally covers both the detergent and dispersion properties. Some have one of these properties alone, while others combine two or more of them. The most successful have been the compounds combining at least the last two properties, and preferably all three. Compounds which are only inhibitors have quite often proven successful in one or more types of Diesel engines but not in others.

Similarly, compounds which are merely detergents and dispersers, but not inhibitors, are limited in application because they do not prevent or retard oxidation of the mineral oil base, and are therefore corrosive to alloy bearings. The first compounds of the detergent type to show promise were oil-soluble soaps which were reasonably good detergents, but which were oxidation accelerators rather than inhibitors. These could not be employed in engines containing alloy bearings of a corrosion susceptible type. More recently, other metallic compounds or mixtures of compounds which have combined all three properties have been developed, and are being used successfully.

Best overall engine performance can be obtained only with lubricants having a proper balance between detergency, dispersion, and inhibition. A lack of any one of these properties results in serious limitations of the oil for application to heavy-duty Diesel service. Painstaking care in the selection of both additive and base stocks is therefore necessary in compounding wholly satisfactory Diesel lubricants, and both lengthy and extensive testing is required. As in the case of bearing corrosion, laboratory test methods generally fail to correlate with engine performance, and are often misleading.

It is rather remarkable that a relatively small quantity of added synthetic compound can improve the performance of a lubricant as effectively as demonstrated by engine tests. Consequently, it would be of interest to know how the additive accomplishes its effects, particularly since an understanding of its action helps in predicting more completely what results may be expected in different applications and under various conditions.

It is believed that the benefits obtained by the use of the detergent - disperser - inhibitor additive can be ascribed to three effects: (1) The additive disperses and holds solid particles of deterioration and contamination products in suspension in the oil, and thereby prevents their deposition on engine parts as sludge, varnish, and ring zone carbon; (2) It retards the deterioration of the oil, and the consequent formation of products corrosive to copper-lead and similar bearings, as well as substances otherwise objectionable; (3) It increases the adhesion of the oil to the metal parts of the engine, thus helping the lubricant resist displacement by heavy rubbing loads, high temperatures and corrosive vapors, and as a result it reduces engine wear.

In the use of any lubricant, practical operating questions arise as to oil change practice, the use of filters, etc. Since the answers are to a large extent determined by service conditions which do not lend themselves to quantitative expression, recommendations must necessarily be indefinite.

Practical Considerations

Conventional lubricants appear to deteriorate largely through the progressive chemical destruction of the bulk of the oil, and hence their loss in performance is quite often largely proportional to their length of service. In additive-containing oils, the deterioration of both the oil and the engine is retarded by the additive to provide the superior performance noted. However, during operation, the power of the additive may be gradually exhausted, and better results are therefore obtained if the oil is replaced regularly before the effectiveness of the additive is wholly spent. Consequently, for optimum performance, a sound oil change practice is even more important with additive blends than with conventional oils.

Make-up oil, used to replace that consumed, may also have an important bearing on engine performance. The make-up oil helps to replenish the supply of additive and to renew the dispersing, stabilizing, and wear-reducing properties of the lubricant. Occasionally, consumption is increased upon changing to an additive-containing oil, probably because the rings are kept freer and hence let more oil pass, or because the oil wets the metal better and flows more readily to hot engine parts, which often act as a barrier to conventional oils.

When an oil is charged to a dirty engine, it may loosen sludge and varnish deposits. These loosened deposits may be very heavy and, if not removed, may become serious enough to cause trouble. While no difficulties of this type have ever come to the authors' attention, they should nevertheless be guarded against.

Consequently, any engine changed over to a detergent blend should first be thoroughly flushed, and then, after running a nominal period on the new oil, the crankcase should be drained and recharged. Thereafter it should not require as much special attention. However, when engine deposits are being assimilated with difficulty by the blended oil, several oil changes may be necessary before the purging of the engine is completed.

Mixing Oils

It is not ordinarily the best practice to mix the detergent-type oils with others. The addition of

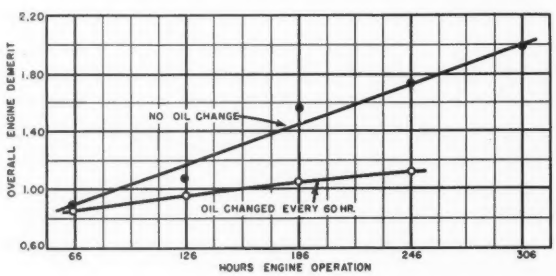


Fig. 1. Effect of oil change on the performance of a specific oil in a given engine. The left hand scale is an arbitrary rating system running from 0 for a perfect surface to 10 for the worst possible condition from the standpoint of deposits

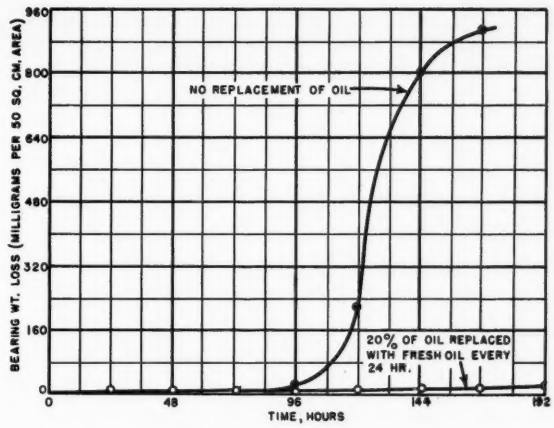


Fig. 2. Reduction in lead-copper bearing corrosion by regular and systematic replacement of the oil supply

a detergent blend as make-up to a conventional oil may cause some cleaning action to occur. This would be beneficial to the engine but the crankcase oil would have to be observed closely to make certain that accumulation of deposits was not sufficient to cause any difficulties. The addition of a straight mineral oil as make-up to a detergent oil, on the other hand, would tend to dilute the additive concentration, thus making it less effective.

At least until more extensive field experience has been accumulated, it would also probably be best not to employ the detergent blend of one manufacturer as make-up for that of another. Although no particular incompatibility would be anticipated, it is possible that the balance between detergent, dispersive, and inhibiting properties might be altered considerably as a result of blending. These views upon mixing oils have not been checked in the laboratory or field as extensively as is desired, and are therefore offered only as precautionary suggestions.

Filter Replacements

When operating an engine on a conventional oil, an effective filter may serve to remove a major portion of the contamination and deterioration products from the oil and thereby delay the need for oil changes. Eventually the filter cartridge becomes choked with solids, and must be replaced. Some operators therefore change filters whenever the oil begins to appear fairly dirty, or when some definite limit of contamination is reached. Filter replacement schedules based on the oil condition require revision when applied to lubricants containing dispersers. Some blends tend to carry finer contamination products through the filter, and consequently the apparent condition of the oil ceases to be a direct measure of the filter efficiency.

Strainer-type filters are of particular interest for use with detergent-containing oils. Since, as the power of the additive is spent, it loses its ability to keep such filters clean, some indication of the need for an oil change can be obtained by a quick examination of the filter unit. Once sludge starts to accumulate on the strainer, the oil should be changed. However, the additive may become spent in other ways, as in corrosion-preventive ability, and hence a clean filter is not a complete index of the oil condition.

It is obvious from these few observations that no blanket recommendation will provide optimum lubrication practice in all engines and in all services. What may be an excellent practice for one operator may not be satisfactory for another whose equipment, type of operation, etc., are all different. In general, the engine manufacturers' oil change schedules should be followed, and in no case should an additive blend be changed any less often than a conventional oil, until the operator has become quite familiar with the new product.

It should be emphasized that these improved oils provide better lubrication and keep engines in a better mechanical condition than conventional oils; thus, they help to keep equipment operating more efficiently, minimize costly and annoying breakdowns, and reduce maintenance expense.

HANDLING OF ELECTRICAL FIRES

The Why and How of Fire Protection With Carbon Dioxide Gas

By P. W. Eberhardt
Walter Kidde & Co., Inc.

IF YOU wake up some night, roused by the crackling of flames and by your wife screaming, "The house is on fire," your only worry will be to get the fire out as quickly as possible. You will fling water on the blaze, not worrying too much whether or not you saturate your easy chair with water, or ruin the handsome set of "The Collected Works of Eugene Field," which you got for Christmas last December.

With electrical fires, however, it's a more complicated story. Your first worry is to limit the fire to the point of rupture, that is, keep it from spreading; then you want to put the fire out with the least possible damage by the extinguishing medium; and, last, you want to re-establish service just as fast as you know how.

One of our own engineers came upon an interesting tableau when he rushed to the scene of a manhole fire which had broken out a few blocks from his hotel. He followed a few minutes after the fire trucks had gone by and arrived to find a representative of the public utility company playing Horatius-at-the-Bridge in the face of demands by the fire chief that he be allowed to turn a hose stream into the manhole. The public utility man was exactly right in his insistence that the

fire department keep hands off, since they lacked equipment to kill the fire without serious damage and long interruption of service. They might have stopped the fire; they assuredly would have played havoc with the equipment.

Three Phases of Fire Fighting Problem

Thus, fire fighting is a three-phase problem where electrical equipment is concerned. Problem One is rapid extinguishment; Problem Two is keeping the damage down; Problem Three is keeping outage at a minimum. To solve these problems utility companies and power plant engineers are turning to a more scientific fire fighter—carbon dioxide. In controlling electrical fires carbon dioxide gas acts primarily on the principle of smothering the fire. Release of this gas into the fire zone reduces the percentage of oxygen, stops the propagation of flame, and brings the fire under control. There is also a certain cooling action in the application of carbon dioxide gas, since some snow is produced at –110 deg. F., which assists materially in reducing the temperature.

The characteristics of carbon dioxide which make it particularly applicable to fires involving electrical apparatus are, first, a higher dielectric strength than air; second, absolute dryness, producing no moisture; third, complete absence of solvent action on insulation and corrosive effect on wiring or the equipment involved; fourth, no residue, which means no extensive clean-up; and fifth, non-freezing at lowest climatic temperatures, thereby permitting its storage in unattended and usually unheated substations.

Carbon dioxide gas is available in small trigger-control portable extinguishers, with a capacity of 2 lb. of gas, up to big wheeled portables carrying 100 lb.

These portable carbon dioxide extinguishers are usually employed in the protection of industrial power plants, control panel wiring, oil switches, and starters. These extinguishers carry, for their size, an exceptionally heavy "punch" against fire. They are ideal for fighting blazes in flammable liquids, such as oil, grease, paints, lacquers, etc. Carbon dioxide is an extremely versatile fire fighter and the carbon dioxide portable extinguisher guards a wide variety of fire hazards in public utility plants and throughout industry.

Automatic Systems

It is probably the built-in system type of application which has brought carbon dioxide fire extinguishing into greatest prominence. The availability of this fire fighting substance in large volumes makes possible its automatic application to oil switches, transformer rooms, generators, and all types of rotating electrical machinery. This development eliminated the necessity of direct application on the part of the operator, removed him from the scene of danger, making the extinguishing of fire a safe operation, rather than a hazardous one. More than that, it entirely removed the human element, eliminating panic, bad judgment, or even complete failure to act. In an emergency the machine is more reliable than the man—every time.

Unattended and customers' substations are exceptionally logical spots for automatic fire extinguishing installations.

There are two types of built-in carbon dioxide fire protection. The first type known as "total flooding," is designed to fill a given room from floor to ceiling with carbon dioxide gas, so that fire cannot exist at any level.

Another use, relatively infrequent in electrical generation and distribution, is known as "local application." This involves a concentration of carbon dioxide at a particular localized area within a room, based on the use of discharge nozzles which are placed directly above the hazard area.

Characteristic of both types of application is the mobilization of sufficient quantities of carbon dioxide in batteries of cylinders which are usually placed at some point safely remote from the area in which the fire hazard exists. A piping system conveys the carbon dioxide gas to the spaces, where it is discharged through shielded nozzles which spread the gas without turbulence.

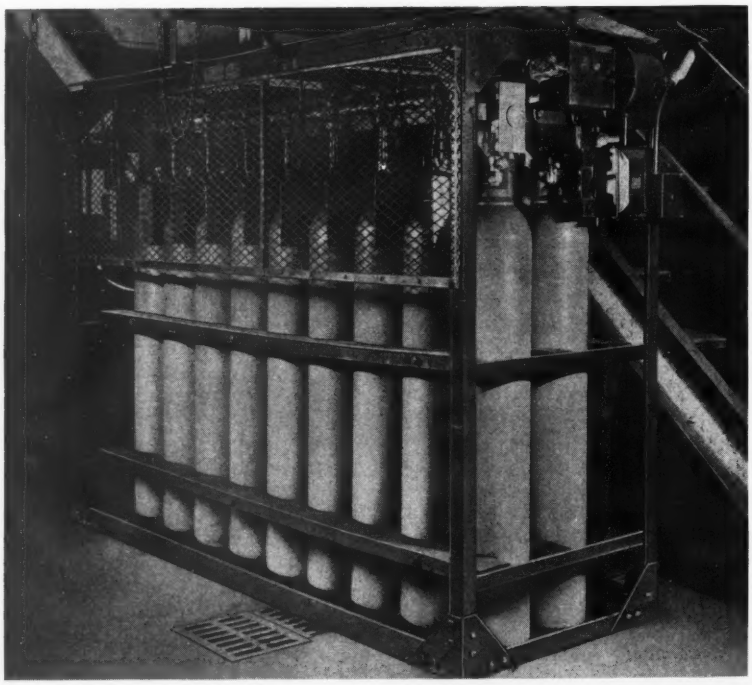


Photo courtesy Walter Kidde & Co., Inc.

Fig. 1. Approved safety practice usually locates the carbon dioxide cylinders at a point safely removed from the fire area. Shown here is a battery of 18 cylinders containing 900 lb. of fire-fighting gas

Requirements of Flooding System

In planning a "total flooding" installation, the number of carbon dioxide cylinders is dependent largely upon the volume of the space to be guarded. Generally speaking, one 50 lb. capacity cylinder is applied for every 1000 cu. ft. of contained air space. It is well to remember, too, that any number of rooms can be protected from the central carbon dioxide battery. The most economic set-up is to plan the size of your system on the basis of the largest space in the plant, and to divert

the gas to whichever spot fire breaks out, through the use of directional valves which may be operated either by hand or automatically.

The discharge nozzles are placed around the periphery of the room at an elevation of approximately one-third of the distance of the floor to the ceiling, measuring up. Outlets are placed on approximately 10 ft. centers. The oretically, a 45 per cent concentration of carbon dioxide gas is applied, but due to usual leakage through doors, windows, etc., and actual concentration of 35 per cent is established. This gives a tremendous safety factor and will control any fire experienced within the space whether of burning insulation or oil.

Most important in the electrical field is the application of carbon dioxide fire protection to rotating electrical machines, including generators, synchronous condensers, frequency changer sets, and rotary converters. In these instances, the entire housing is flooded with carbon dioxide gas, with leakage compensated for by delayed discharge. This is a variation of the "total flooding" type of system.

Proper fire fighting practice in rotating electrical machines calls for, first, rapidly building up a volume of carbon dioxide sufficient to extinguish flame within the first few cycles after the fire breaks out. The second problem is to control the incandescent glow during the shut-down period. A typical 20,000 kv-a. generator may require a system of ten 50 lb. carbon dioxide cylinders. Four cylinders are immediately applied to kill flame during the first few seconds, the six remaining cylinders discharge, one after another, for 30 min. or until the machine runs down without application of the "field."

Fire Detection

The automatic operation of built-in carbon dioxide extinguishing systems is usually based upon automatic fire detection. This detection may be accomplished in the three following ways and these are mentioned in the order of their greatest efficiency.

The first type of automatic protection for rotating machines is based on differential protection relays. These are constituted

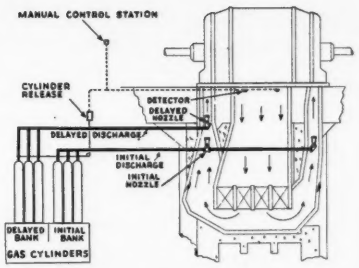


Fig. 2. Diagram of built-in carbon dioxide fire extinguishing system for electric generators. Shielded nozzles direct discharge of the gas into ventilating ducts where direction of air flow is shown by arrows. One set of cylinders handles the initial discharge to extinguish the fire. The delayed bank of cylinders operates during the period which the generator requires to come to full stop, and this discharge controls the incandescent glow and compensates for gas lost through leakage

chiefly of current transformers, connected across the primary of the generator leads. The secondary of these current transformers is connected across the low current overload and ground relays which, in turn, close contacts when an unbalanced condition occurs in the machine. This unbalanced condition usually shows a short circuit or ground due to insulation, or mechanical breakdown within the machine. The closing of the contacts on the relays is employed to shunt out the field switch connected to the exciter coils, open up the oil circuit breaker connected to the machine so that electric feed-back from other sources of power will be disconnected. In some cases the relays are used to control the steam throttle or apply brakes, such as those used on hydro machines. This same circuit is also employed to release the carbon dioxide system and the time of operation required is usually about 2/5 of a second.

Fixed electric thermostats can be placed in the exhaust air duct of the machine. It is normally recommended that 212 deg. F. thermostats be employed. The operation of these thermostats due to reaching this temperature causes automatic operation of the carbon dioxide system and, where differential relay protection is provided, a fixed thermostat circuit is usually tied into the differential relay circuit to cause it to operate as mentioned in foregoing paragraph.

In oil switch or transformer rooms the fixed temperature detector is usually employed, although in some instances the rate-of-temperature-rise method is used.

In every case in which automatic protection is provided, this is augmented by manual control of the extinguishing system in emergencies. Electric control switch stations are located at convenient points and are connected into the same circuit as the relay or thermostat system.

The electric fire detecting system on the carbon dioxide extinguishing system makes use of the station service batteries, assuring positive operation even though the entire plant is shut down due to disturbances.

Columbium-Iron Alloy Assuming Importance

SMALL amounts of a relatively rare element when added to iron produce an alloy superior to expensive steels in meeting the demands for metals to withstand high temperatures and high stresses, according to E. R. Parker of the General Electric Research Laboratory who first announced the new alloy, at the annual meeting of the American Society for Metals, in Cleveland, last October. This new alloy may make it possible to extend further the temperature at which steam turbines are operated, without involving the expensive steels which seemed necessary before the new alloy was produced.

Columbium, a relatively unfamiliar element and with a minimum of commercial importance at present, produces an alloy of exceptional properties when added in small amounts to iron. Samples containing three per cent of columbium and the balance of iron reveal exceptionally good rupture strength at 1100 deg. F., a temperature not yet commercially used but being approached by modern high-temperature, high-pressure steam turbines. No carbon is contained in the alloy, so it is not a steel; instead, the iron contains the columbium as a finely dispersed stable compound of iron and columbium.

Special steels are readily available to answer the demands of turbines operating at today's highest temperatures—about 1000 deg. F. —but for temperatures as high as 1100 deg. the increased contents of molybdenum, tungsten, vanadium, or such metals, would make them too expensive for turbines.

Part II. Some fundamentals about humidity and temperature. Why the electric fan does not affect the reading of the thermometer. A trip to Frosty Coldfax where you sort of get mixed up with refrigeration and sex appeal

REFRIGERATING ENGINEER

By GEORGE HOLMAN

"IT AIN'T the heat; it's the humidity."

You dislike this remark but indirectly it is responsible for your getting into the refrigerating game. You hear it on a hot day shortly after the June 21st explosion at the Wholesome Ice Plant and Food Market. Unable to find another job after finishing repairing the fence at the farm you are sweating in your garden; you are supposed to be hoeing. The temperature is 82 and there is no perceptible movement of air.

About 3 o'clock in the afternoon along comes Allen Knowles. Rusty Cameron has moved up to managing engineer of the Wholesome plant. Andy Piper has taken Rusty's old shift and Allen has been employed to fill in the second shift until Montgomery La Mar is able to go back to work.

Allen says, "Hello, Abel. How are you making it today?"

It ain't the heat; it's the humidity

Without thinking that you are leaving yourself wide open for the comeback you moan about the heat. And then it comes.

"It ain't the heat; it's the humidity," says Allen.

You start after him with the hoe and he runs but you get to thinking about the humidity. What is it? It is only 82 today yet it seems hotter than yesterday when it was 90.

Deciding you have done enough gardening you go into the house, take a thermometer and stand it in front of the electric fan. You intend to find out just how much cooler the fan makes the air.

You do. When you put the thermometer in front of the fan it read 82 degrees. In the breeze of the fan it still shows 82. You shake it, then look again. Still 82. Something must be wrong with it. Any fool knows it's cooler in a breeze than out of one.

So you take the thermometer into the kitchen and stick it into the refrigerator. It drops to 42 deg. and then you rush back into the living room and hold it up in front of the fan. Back it goes to 82 degrees!

Funniest thing you ever heard of. You stand in the breeze and try to think. Certainly the breeze is cooler than the air in the room. But why doesn't the thermometer show it?

But even the fan does not cool you as much today at 82 as it did yesterday at 90 deg. Why is that? You leave the meager comfort of the fan and head downtown for the public library, a small one but the only one in town.

Lucy Booker is in charge. After some discussion and kidding you leave with a book on refrigeration and once more at home in the breeze of the fan you thumb your way through the book. Here and there you read short paragraphs. Much of it is "Greek" to you but you continue until you come to a psychrometric chart. This looks intriguing and it may answer some of the questions in your mind. Unfolding it, you come across the phrase, "Grains of moisture per pound of dry air."

"That must be a misprint," you muse. "A pretty bad error for a high class book like this."

Visit to Frosty Coldfax

But in your consternation you find in the text a similar phrase, "Dry air saturated with moisture." The expression doesn't make sense, for the only things that you have ever saturated with moisture were a long way from being dry. The third time you find the assertion that there is moisture in dry air, you realize that the book means what it says. You get up and close the book. With the book under your arm, you set off down the street. At the corner of Tenth and Washington Streets you find a pair of ice tongs hanging from a post set in the front lawn. In the house behind the tongs Frosty Coldfax lives. If anybody in town can explain humidity to you, Frosty Coldfax can.

Frosty's house is air conditioned, so the door is kept closed, even in summer. As you rap a light but firm set of footsteps comes along the hall. The door opens, and before you stands Frosty's seventeen-year-old daughter, June. People don't call her June Coldfax, though. They call her June Frost. You wonder why, and suppose that it is because she is so cool and so rare a type—until you learn better.

You don't remember seeing June since she was a freckle-faced little brat riding around with the ice men in her father's delivery trucks. Right now her freckles have disappeared. She has a square little chin, a funny pug nose and a mouth that looks as if it could stand being kissed a few times. "What do you want?" she asks cooly, disapproval of your presence radiating from her like the ripples from a rock dropped into still water.

You are not bold enough to state just exactly what you want at that instant. You remember what you came for, and say, "I'd like to talk to Mr. Coldfax, if he isn't too busy."

June lets you in and closes the door. You follow her down the hall and walk under the draperies she holds aside for you. You find yourself in a room which seems to be a combination office, library and chemical laboratory, judging from the papers, typewriter, books and the apparatus on a bench along one wall.

Frosty is seated at a desk. He has a pencil in one hand and a stack of papers before him. "Good evening, Abel," Frosty says, while June Frost looks quickly from her father to you. "Take a chair. What's on your mind?"

Enter, Sex Appeal

You say rather briefly, "Humidity." But that isn't quite true. What you mean is that you *did* have humidity on your mind. Right now what you have on your mind is June Frost. She has followed you into the room, and is now tucking at her hair and looking at the picture in the mirror of a vanity case lying on the table. You must admit that it is a nice picture to look at, for only at a different angle you are doing the same.

Frosty is asking rather dryly, "Are you sure it isn't coal oil or coffee grounds that you have on your mind?"

Something in Frosty's voice makes you feel guilty. The temperature of your face rises. But you insist, rather weakly, "I'm sure it is humidity."

"Your face doesn't look like you've got humidity on your mind!"

"But I have," you still refuse to plead guilty.

"All right. We won't argue," Frosty grins, and looks at June Frost. "Relative or absolute?"

"I didn't know that there were two kinds."

"There aren't. But there are two common angles from which humidity is viewed."

"Which way is the right one?"

"Neither. But maybe I say that because I don't like the methods now used."

"What's wrong with them?"

"The use of misleading terms and of factors which vary in their practical usage. Relative humidity, for example. A relative humidity of 50 per cent at 40 deg. is something which differs in practical usage from a 50 per cent relative humidity at 90 deg. I could elucidate, but unless you know the fundamentals of psychrometry, you would fail to understand. Could you be more specific in what you want to know? Ask any question you like."

You remember the heat out-of-doors and at home. "Awhile ago I took the thermometer to find out how much cooler an electric fan made the air," you tell Frosty. "But the funniest thing you know! The thermometer didn't change a bit. I thought it was stuck. But when I put it in the ice box, it went down. Then I took it out and held it in the breeze from the fan. It went right back up to the temperature in the rest of the room. That beats me."

Frosty laughs. "Once you know it, the answer to the behavior of the thermometer in the air current is a simple one," he explains. "The food you eat and the oxygen of the air you breathe unite in your body to form carbon dioxide and water, with constant release of heat. This heat keeps the temperature of your body at 98 deg., even though heat is constantly escaping to the air and to surrounding objects. If the heat did not escape, it would produce an excessive temperature rise which would result in death. Even a slight temperature rise makes us feel uncomfortable."

"Now heat can flow only from a higher temperature to a lower one," Frosty goes on to say. "As air at 82 deg. flows around your 98 deg. body, it takes up heat and is warmed. If the warm air stays against your body, it will finally reach the same temperature as your body, and the heat loss from the body will cease. You will feel very hot, and heat prostration will soon follow. But if air, even warm air at 80 or 90 deg.—just so that it is less than the temperature of the body—is circulated very rapidly about the body, it will take up the heat more rapidly, and we will feel cooler. The stronger the air current, the more heat will be carried away from the body. The air isn't made any cooler by the fan. But you feel cooler because you are losing heat faster, not only directly to the air, but also by evaporation of the perspiration being exuded from your body."

Dry Air and Wet Air

This all sounds reasonable, but you think of another question. "What," you ask, "is the difference between wet air and dry air?"

"That is easily answered," Frosty says. "Wet air is visible; dry air is perfectly transparent, unless it has dust or smoke in it."

"Is all wet air visible?" you ask, somewhat perturbed.

"Yes. But this answer requires explaining. You do not actually see wet air. You see only the minute particles of liquid suspended in it. Clouds and fogs are splendid examples of wet air."

"Are you sure that wet air must have particles of liquid in suspension in it?" you ask, still in doubt.

"What else but liquid in it could make it wet?" Frosty counters. "Gas or dust or smoke wouldn't make it wet, would they?"

You grudgingly admit that Frosty has a logical answer to your question as to what makes wet air wet. "All right," you tell him. "Wet air is visible; dry air is not. Now, can you tell me what this book means by dry air saturated with moisture; or by grains of moisture per pound of dry air?"

"That is one of the things wrong with our treatment of psychrometry," Frosty says. "The terms are technically correct. But their common usage makes them misleading. How do you define the word 'moisture'?"

"Wetness. Something like dew or the drops of water that collects on the walls of caves, basements and cellars."

"That's where your definition and the definition implied by the use of the word in your book differ. The word as used there cannot be defined as wetness. What it means there is water vapor, or steam."

Steam in the Air?

Steam! Steam in the air? What nonsense! "If there is steam in the air, why can't we see it?" you demand of Frosty.

"That's easily answered," Frosty says. "Pure dry steam is just as invisible as pure dry air."

"Pure steam is invisible?" you query. "Then what is it you see when you open a steam nozzle?"

"Wet air; or wet steam. One or the other, and for the purpose of our argument it makes no difference which. It is the wetness that you see. Tiny drops of liquid suspended in steam will make it just as visible and just as wet as if the drops were suspended in air or any other gaseous substance."

Again you grudgingly admit that Frosty's argument seems logical. And again you think you have found a weak point in it. "If there was steam in the air, it would burn us," you announce doubtfully.

"How?" Frosty laconically asks. "Neither steam nor anything else can burn you unless it is hot enough."

"But steam must be hot. If it isn't hot, it can't be steam. It would condense, and be the wetness we mentioned awhile ago."

"And where does the wetness condensing on walls of caves and cellars come from?" Frosty asks. "Does it always come from wet, visible air?"

While you are trying to find an answer to Frosty's question June Frost gets up and hurries from the room. In a minute she is back, a half dozen cubes of ice in a tin cup.

"Watch the outside of that cup," Frosty tells you, and you watch until the misty film forming on the outside of the cup changes into big droplets which run down the cup to the table. "Where does the water collecting on the cup come from?" Frosty asks.

"The air," you answer quite readily.

"And where will it go to after the ice in the cup melts and the cup warms up?"

"It will evaporate."

"In other words, it comes out of the air, and it will go back into the air?"

"That's it."

"Would you say that the air in this room is wet?"

"You can't see it—the wetness in it, I mean."

"Therefore it is dry. It is dry, but by condensation you can still get water out of it. You can get the water by condensing the steam the air contains. The substance we call water exists in three forms. As a solid called ice, a liquid called water and a vapor called steam. It's got to be one of the other of the three. If it is neither solid nor liquid, it must be steam. And whatever the temperature is makes no difference. Some steam —or water vapor, if you still want to call it that—exists in air at all temperatures, and the amount depending on what the temperature is and the amount of liquid present from which it can be derived by evaporation."

Physics of Air

"Now, air is not a simple substance, as many people suppose. It is a mechanical mixture of a number of gases, chief of which are nitrogen, oxygen, argon, krypton, neon, carbon dioxide and steam, the latter also called water vapor, but being exactly the same stuff used in a steam engine. There are also small quantities of other gases, hydrogen, helium, and so on. Each one of these gases is a separate and distinct alloy formed by the union of infinitely small particles of the solid or liquid substance and that form of energy called heat. Of all these gases, only one is condensible at the ordinary temperatures and pressures existing in the air we breathe, although all of them can be and have been made liquid when the right conditions of temperature and pressure are established. With the single exception, all gases of the air are always superheated. This exception is also superheated most of the time. Some of the liquid or solid substances from which these gases were formed required more heat per pound to form gases than others did. And after they have been formed, a pound of one may require more or less heat than another to raise its temperature one degree or the same number of degrees."

"But here are some things for you to think about," Frosty goes on seriously. "All of these gases, with the single exception of steam, expand and contract directly as their absolute temperatures measured above the absolute zero of 460 deg. below the zero on the Fahrenheit thermometer. That is true only if their pressures remain the same. And the other way around, if these gases are held in a confining vessel so they can't expand and heated to twice their original absolute temperatures, they will double their pressure in pounds per square inch. For example, if you seal a bottle containing nothing but a true gas or true gases at zero Fahrenheit and heat it to 460 deg. above that point, the pressure in it will be doubled. If filled with air from which the steam has been removed, and at atmospheric pressure of 14.7 lb. per sq. in. the pressure in it will rise to 29.4 lb. per sq. in. absolute, or to 14.7 lb. per sq. in. gage. If you would put a cubic foot of gas in a toy balloon at zero, and then heat the balloon to 460 deg. above zero, it would be found by measurement to contain two cubic feet of gas. In the presence of the liquid from which it was formed, a gas will not follow these laws precisely, but vary somewhat. This relationship of temperature and pressure in the physics of gases was discovered and clarified by Boyle, Charles and Gay-Lussac."

"However," said Frosty looking at the clock, "now we are getting into some of the more complicated aspects of the physics of gases and I suggest you read up on the subject before I try to explain them further. Look up Boyle's Law, Dalton's Law and Avogadros Law in the encyclopedia or in any good physics book and you will discover a number of interesting facts about air and other gases which will be useful to you if ever you get into refrigeration."

You get up, quite relieved. Frosty has given you your money's worth. You thank him, get up and start out, then turn back. "How about a job at the Aurora?" you ask, and explain, "I've asked about everybody else in town for a job so I might as well ask you too."

Frosty shakes his head regretfully. "No opening now; but if there ever is one, I'll remember you."

June Frost follows you down the hall and hands you your hat. "Daddy sure is a wizard on engineering, isn't he?" she asks.

"You bet," you say, thinking of witches as well as wizards. "I'm going to come and talk to him about refrigeration sometime. I'd like to be a refrigerating engineer."

Outside the door you remember that you have forgotten your book. But that is all for the good. A good alibi for calling at Frosty's home again. But what the dickens! Something cold running down your thigh. Good Lord! A piece of ice in your hip pocket. How in thunder did that get there? You turn around just in time to see the door close for the second time, and June Frost's silvery laughter coming from behind it.

The practical joke loses its irritativeness. You grin and wave as June Frost peers out a window. She thumbs her nose at you, and draws the curtain. In very good humor you walk on, a second visit to Frost's home now a certainty. Your wet hip pocket no longer annoys you, and you even grin about it. Here you have gone to see Frosty with humidity in your head; and now you're going home with humidity in your pants. What a life!

At home you go to bed with enough on your mind to keep you awake for awhile. At last you fall asleep. You dream that you are building a high board fence to keep an atmosphere of true gases in your yard. A lot of other things happen.

Just before you awaken you find that you have climbed up on a steam boiler to knock the icicles off. While you are up there someone pushes the boiler out from under you. You hang on to a steam pipe. June Frost comes along and starts firing atoms and molecules at you with a beanshooter.

(To be continued.)

HOT WATER FLOW THROUGH ORIFICES

Test data for flow of saturated water, and mixtures of water and steam, through throttling orifices for draining extraction heaters and for continuous blowdown. Discharge coefficients are approximately the same as for cold water.

By M. W. Benjamin[1] and J. G. Miller[1]

EARLY in 1939, the authors became actively interested in the flow of boiling water through pipes in connection with the rapid erosion of elbows in heater drain piping. After some study, it was found that erosion was a function of the amount of flashing and the quantity of water flowing in the pipe. Interest in the subject was intensified by the indication that certain operating difficulties with float-operated condensate drainers also might be traced to the phenomena encountered with water flashing into steam in the drainer discharge pipe.

Orifices used in place of float-operated traps for draining feedwater heaters would eliminate the operating troubles with traps and, if the orifices were installed at the end of the drain line rather than at the beginning, would prevent erosion in the piping.

Since the available test data were not complete and because practical coefficients were needed for actual design purposes, it was decided to conduct an experimental investigation of the flow of saturated water through sharp-edged thin-plate orifices to determine whether it would be practicable to use such orifices in lieu of traps for draining feedwater heaters.

The term saturated water is used in preference to hot or boiling water since it is considered to be more definite and possibly more accurate. It is used to denote water at saturation pressure and temperature, and refers to the condition of the water on the upstream side of the orifice. The effect of undercooling on the flow of the condensate through an orifice is in general the same as the effect of a static head on the upstream side.

Drainage of condensate from a higher-pressure to a lower-pressure feedwater heater is primarily a throttling process and the controlling factors to be considered for maximum load on a turbine are: (a) the pressure differential between the heaters; (b) the initial temperature and pressure of the condensate; and (c) the quantity of condensate to be drained from the higher-pressure heater. The initial temperature of the condensate will be the saturation temperature corresponding to the initial pressure in all cases except those in which there is undercooling.

All of the factors given decrease with a drop in load on the turbine. It is possible that an orifice designed for full load will be larger than needed to pass the condensate at reduced load even though the pressure differential across the orifice also is reduced. In such a case, some steam will be cascaded to the lower-pressure heater along with the condensate. This means that more steam will be bled from the higher-pressure turbine stage than is necessary for its own stage of feedwater heating, which in turn may reduce the turbine cycle efficiency somewhat, especially if the amount of steam cascaded is excessive.

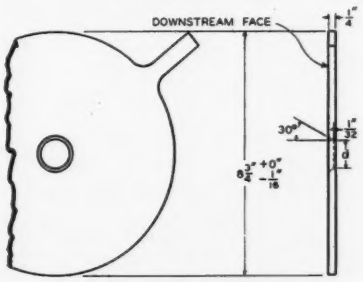


Fig. 1. Design of orifices used in tests. They were made of low carbon steel with the upstream side finished in a lathe

[1]Both authors are engineers in the Engineering Division of The Detroit Edison Co. This is a portion of a complete paper presented recently before the A. S. M. E. For data on the design of temporary flat plate orifices for metering purposes see p. 997 Sept. 15, 1926, p. 1273 Dec. 1, 1927 and p. 440 Apr. 1, 1929, Power Plant Engineering.

While it is not an established fact, it is expected that long-continued throttling may produce wear or erosion of the orifice with consequent passage of steam at all turbine loads. To prevent loss of cycle efficiency it might be necessary to make periodic replacements and, for this reason, any heater drain-line orifice should be simple to make and easy to replace in service.

If the orifice plate is made of corrosion-resisting steel, experience shows that, where no change of state occurs, there will be little if any wear of the sharp edge of the orifice; however, with orifices installed in hot-drip systems, considerable erosion due to flashing or cavitation has been noted on the downstream face of the orifice plate. It should be noted here that drain-line orifices are not intended for metering purposes.

Figure 1 shows the design of the orifices used in this investigation. These orifices were installed in a horizontal 6-in. pipe and the orifice diameters ranged from 0.247 to 0.879 in. Actual flow of saturated water through orifices, on the basis of pounds per second per square foot of orifice area as found on test for three initial pressures and various back pressures, is presented in Fig. 2 as the top curve in each of the three sets. The results given were obtained from tests of all the various sizes of orifices.

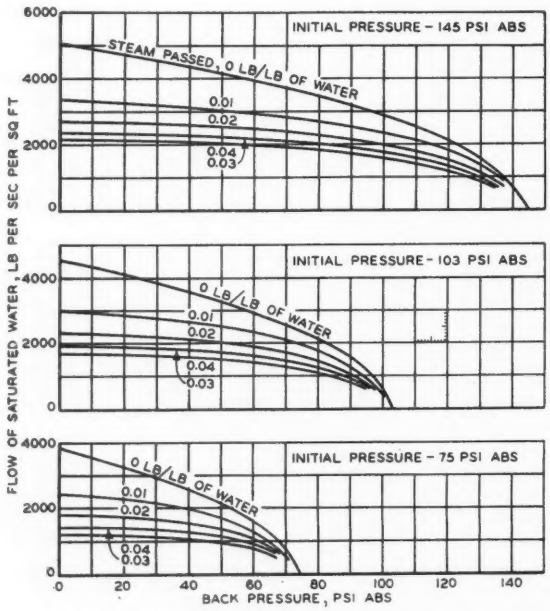


Fig. 2. Actual flow of saturated water (curves marked "steam passed, 0 lb./lb. of water") and various mixtures of steam and water. The steam flow is given as pounds of steam per pound of water

Figure 2 also shows the flow of saturated water when a mixture of steam and water is passed through an orifice. It is important to note that the amount of steam passed is given as a fraction of 1 lb. per lb. of water and that the total weight actually passed by the orifice is the sum of the weights of water and steam.

Should the rate of supply exceed the capacity of an orifice, a static head of water will build up above the orifice. Therefore, the water at the orifice center line will be under a pressure in excess of the saturation pressure corresponding to the temperature by the amount of the static head.

Under this condition the fraction of water flashed into steam in passing to a region of lower pressure will be exactly the same as though the orifice were merely submerged, but the capacity of the orifice is increased somewhat as a result of the increase in pressure drop across it represented by the static head. An equivalent case is one in which the orifice is passing hot water at a normal level but undercooled to some extent below the saturated temperature.

An orifice, operating between fixed initial and back pressures, will pass a given amount of saturated water according to data in Fig. 2. If the amount of saturated water available is less than the orifice is capable of passing, a small amount of steam will flow through the orifice with the water. The amount of steam which will flow depends upon the initial pressure, the back pressure, and the quantity of water available.

For instance, if the initial and back pressures are 145 and 40 p. s. i. abs., respectively, and the amount of saturated water to be passed is 2600 lb. per sec. per sq. ft. of orifice area, Fig. 2 shows that 0.02 lb. of steam will pass through

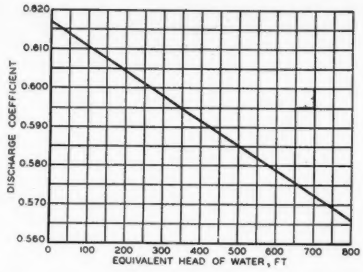


Fig. 3. Discharge coefficients for flow of saturated water through sharp plate orifices

the orifice with each pound of water. It is seen that the water flow from 0 to 0.04 lb. per lb. of water shows a considerable variation. However, for an increase in steam flow above 0.04 lb. per lb., the change in water flow is much slower.

The curves shown in Fig. 2 are of the same general shape as the curve giving the flow of "cold" water (70 deg. F.) through orifices, which is represented in the equation:

$$Q = CA\sqrt{2gh} \quad \ldots\ldots\ldots\ldots (1)$$

where Q = the flow in cu ft. per sec.; A = area in sq. ft.; h = head in ft. of flowing fluid, and C = orifice coefficient. By substituting wv for Q and (144 ÷ d) (p_1-p_2) for h, the equation takes the form

$$\frac{w}{A} = dC\sqrt{2g\ (144 \div d)\ (p_1-p_2)} \quad \ldots\ldots (2)$$

in which w = weight of flow in lb. per sec., p_1 = initial pressure in p.s.i. abs., p_2 = back pressure, v = specific volume of saturated water at p_1 in cu. ft. per lb., and d = density of saturated water at p_1 in lb. per cu. ft.

When saturated water flows through a sharp-edged orifice, no flashing occurs until after the water is through the orifice and, contrary to the theory which is based on a change of state, no critical-pressure condition is evident.

When calculating the flow of saturated water through an orifice, it is important to remember that the value of the head to use in the formula is the equivalent head in feet of water, based on the pressure drop across the orifice and the density of the saturated water.

As in the case of cold water, the orifice coefficient decreases with an increase in pressure differential (head) and orifice diameter. There is also some indication that

the coefficient decreases as the initial temperature (saturation pressure) increases. Fig. 3 gives average values of the orifice coefficient for different values of differential head.

Equation (2) and the orifice coefficient given in Fig. 3 may be used also to calculate the flow of saturated water through an orifice when there is a static head. In this case, however, the density of the water depends upon the temperature rather than the pressure at the orifice.

Two important functions performed by a float trap on a feedwater heater are draining the heater and maintaining the proper pressure differential between the heater and the drain receiver. The float-operated drainer performs these functions by means of a balanced valve, actuated by a float, which responds to changes in hotwell level determined by the quantity of drains. However, these two functions can be performed also by a fixed opening such as a pipe or an orifice and the size of the opening may be varied over a wide range without causing operating difficulty or appreciable thermal loss.

Whether the turbine cycle efficiency will be affected adversely by cascading some steam between heaters at partial loads depends upon the relative energy drop from the throttle to each extraction point and to the condenser, the method of returning the heater drains to the feedwater circuit, and the relative amount of partial-load operation.

In cases which require the use of float-operated drainer traps to eliminate thermodynamic losses, due to cascading steam at partial loads, it may happen that an orifice installed on the down-stream side of the trap will overcome certain operating difficulties with the trap. In some instances, the large pressure difference between heaters at high turbine loads may cause so much unbalance in the trap valve that the float can no longer operate the valve with the result that the heater floods.

When an orifice is installed in series with a trap, the pressure drop between the heaters is divided between the trap and the orifice. By properly designing the orifice, the drop across the trap can be reduced sufficiently to permit the float to operate.

STEAM SAMPLING TO DETECT CORROSION

Corrosion caused by dissociation of steam into its elements may be indicated by separating the gases from the steam and analyzing them quantitatively. Equipment for degasifying a steam sample is described

By C. E. JOOS
Cochrane Corp.

IN THE operation of high pressure boilers, it has been noted that corrosion of some furnace and superheater tubes has occurred in spite of the use of the most modern and effective methods of mechanical and chemical deaeration.

This type of corrosion has been definitely established as due to oxygen, and the corrosion product has been a hard, brittle magnetic oxide of iron. The possible cause of this type of corrosion is the oxygen formed in the tubes as a result of dissociation of steam at high temperatures. With furnace tubes, this may be possible through sluggish circulation in which considerable steam is formed and separated from the water. This steam, in contact with the upper portion of the tubes at high temperature, presents a condition favorable to dissociation in which the steam is broken down into its component elements of hydrogen and oxygen.

With superheater tubes the same possibility exists wherever the tubes are subjected to unusually high temperatures. The oxygen, so formed under these conditions, will have a strong affinity for the iron combining with it to form a magnetic oxide Fe_3O_4.

The chemical reactions involved in the dissociation of steam and in the combination of oxygen with iron can be represented by the following:

$$2\,H_2O \rightarrow 2\,H_2 + O_2$$
$$3\,Fe + 2\,O_2 \rightarrow Fe_3O_4$$

It will be noted that hydrogen is produced in proportion to the oxygen, but since this is inert to iron, it escapes with the steam. Since much, or perhaps all, of the oxygen combines with the metal, the only available method of determining the oxygen and progress of the corrosion, without waiting for failure, is the separation and measurement of the hydrogen. This is accomplished by the Cochrane steam sampler which was designed specifically for separation of the hydrogen from steam samples so that it could be accurately measured and the progress of this type of corrosion evaluated.

For the determination of steam quality, conductivity measurements are now the generally accepted practice. These determinations, however, must be made on a sample of condensed steam, from which such gases as carbon dioxide and ammonia are completely removed, if corrections are to be avoided. The presence of only small quantities of carbon dioxide (CO_2) and especially ammonia (NH_3), have a marked influence on conductivity measurements, and wherever present they must be determined and a correction be applied if the impurities in steam through carryover of solids is to be determined. The determination of these gases is very difficult indeed, if not impractical with any degree of accuracy, and frequently their determination consumes more time and effort than the principal measurement of conductivity of the sample. Also, since carbon diox-

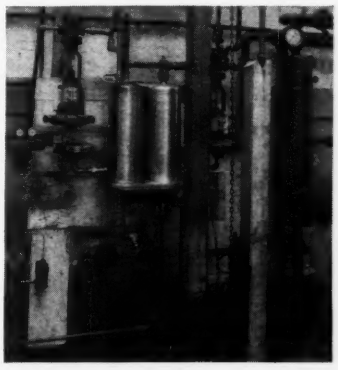


Fig. 1. Steam sample degasifier in factory laboratory

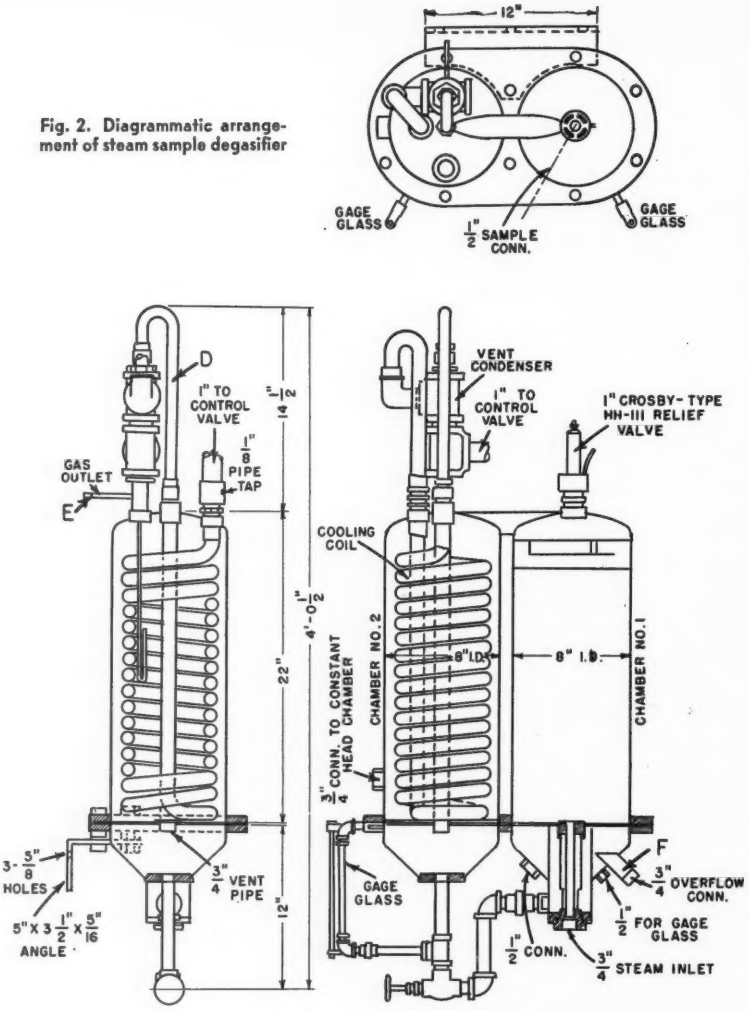


Fig. 2. Diagrammatic arrangement of steam sample degasifier

ide and ammonia would be determined as independent gases and the corrections applied as though they existed as independent gases, it is a fact that when ammonia and carbon dioxide are present in the solution they combine chemically and have an influence on conductivity that differs from the independent quantities. Thus, at best, wherever even minute quantities are present such as 1 or 2 p.p.m. of carbon dioxide or ammonia, there may be considerable doubt as to the correctness of conductivity measurements as applied to carry-over, unless these gases are removed.

The Cochrane steam sample degasifier was designed for the specific purpose of condensing the steam sample, removing the gases therefrom, and separating them for collection so that they can be analyzed by gasometric means. Such gases as hydrogen, oxygen, nitrogen, methane and ammonia are continuously separated, while the condensed sample is degasified and satisfactory for conductivity determinations with little or no correction.

Method of Operation

Figure 2 illustrates diagrammatically the arrangement of the principal portions of the apparatus in which a sample of steam amounting to approximately 250 lb. per hr. is passed through an orifice for reduction of pressure. This orifice is of such a size as to reduce the pressure to approximately 50 lb. per sq. in. gage directly ahead of the sampler. This steam then passes through the atomizer in which practically the entire 50 lb. pressure is used to atomize thoroughly the previously condensed steam, and thus separate it from the water. The principle of operation is similar to the Cochrane atomizing type of deaerator.

The steam vapor and non-condensible gases pass upward through chamber 1 and then enter the top of condensing chamber 2, where the steam is condensed through contact with a coil through which there is passing continuously, a stream of cooling water under careful control. The condensed steam then returns to chamber 1, where it is re-atomized for further degasification. This cycle will continue a number of times, and assures the most effective removal of the gases. The non-condensible gases are withdrawn from chamber 2 to the vent line at D, then condensed through an especially designed vent condenser from which the non-condensible gases are withdrawn at E. The design of this vent condenser provides for minimum entrainment of moisture. These gases are produced in a continuous stream and can be collected for gas analysis at periodic intervals.

The thoroughly degasified water is withdrawn from container 1 at F, and can be passed continuously through the conductivity cell for measurement of carry-over. This record can be continuous by the use of a recording potentiometer.

The equipment is operated at a slight, positive pressure of 1 to 2 in. of water, and this pressure is maintained within very narrow limits by the use of delicate controls in which the flow of cooling water is regulated so as to maintain a pressure so constant within chambers 1 and 2 that the possibility of any breathing action or fluctuation in pressure is avoided.

While the steam sampler is designed for the collection of gases, as well as preparing water for conductivity measurements, it can be utilized for condensing and preparing steam for conductivity measurements alone, in which event it will not be necessary to use as much steam as 250 lb. per hr. This quantity of sample is desirable in view of the small amount of gases present in the steam.

Illustrated here is a design which is the result of over a year's research. Applications have already been made to several very high pressure plants, 1200 to 1500 lb. per sq. in. The containers are made entirely of stainless steel so as to prevent any solution of the metal and thus interference with conductivity measurements for determination of carry-over.

Be Sure INTERRUPTING CAPACITY Is Adequate

BY
R. L. ANDERSON & E. F. KUBLER
GENERAL ELECTRIC CO.

A RECENT STUDY of short circuit values existing at the busses of several substations located at dense load centers in the Pittsfield Works of the General Electric Co. revealed some startling shortcomings as far as interrupting capacity of equipment in service was concerned. Severity of short circuits had been increased by the greater capacity of the plant's generating system in the plant and that of the power company supplying additional power. As a result, many of the old type oil circuit breakers in use—some of which had been installed 15 or more years ago—were found to be inadequate to interrupt the short circuits imposed upon them. Fortunately, they had not been called upon for such service!

The situation at Pittsfield is probably far from unique. In the last two decades, power companies all over the country have been expanding their properties and interconnecting with other systems. Vast networks capable of delivering almost unlimited power have resulted. At the same time, many manufacturing plants have been increasing their own generating facilities. Consequently, breakers capable of interrupting short circuits into which large amounts of energy can be fed are probably lacking in a good many manufacturing plants still using equipment installed when operating conditions were less severe.

Engineers in charge of plant equipment can determine whether

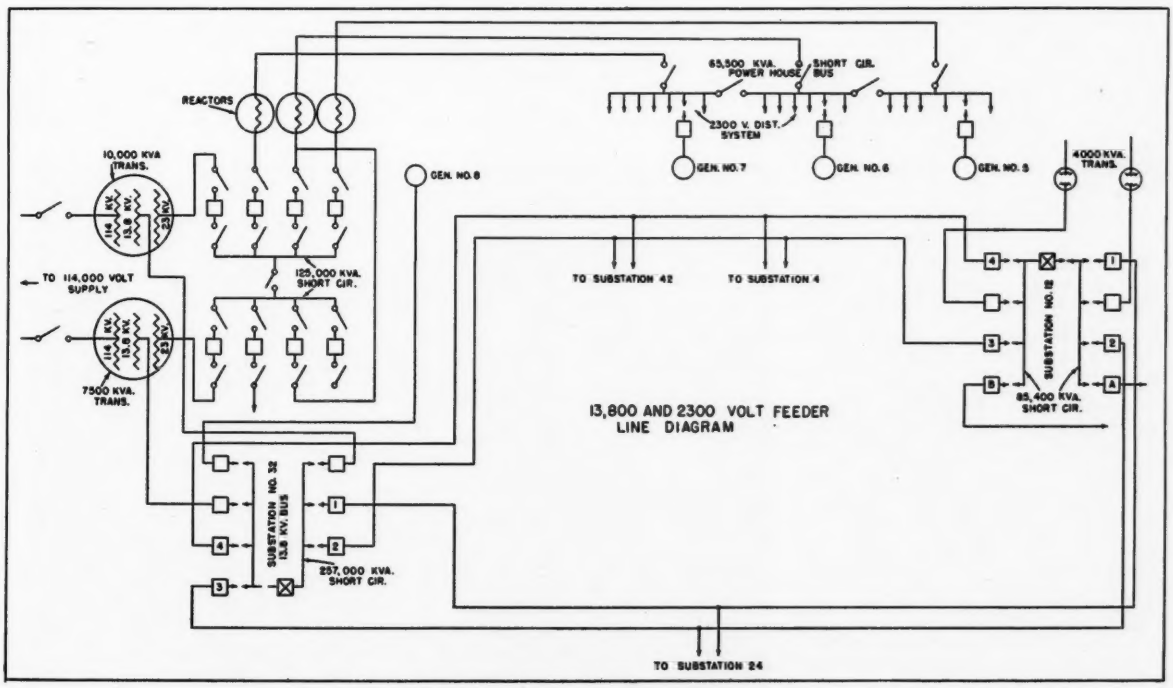
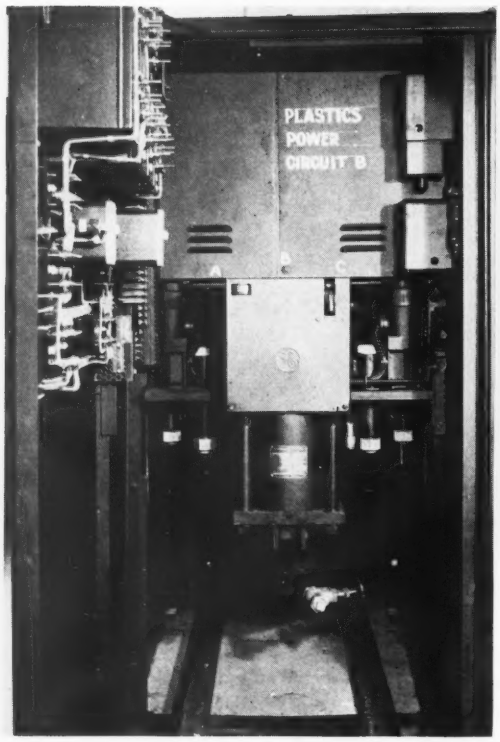


Fig. 1. Single line diagram of the plant's distribution system



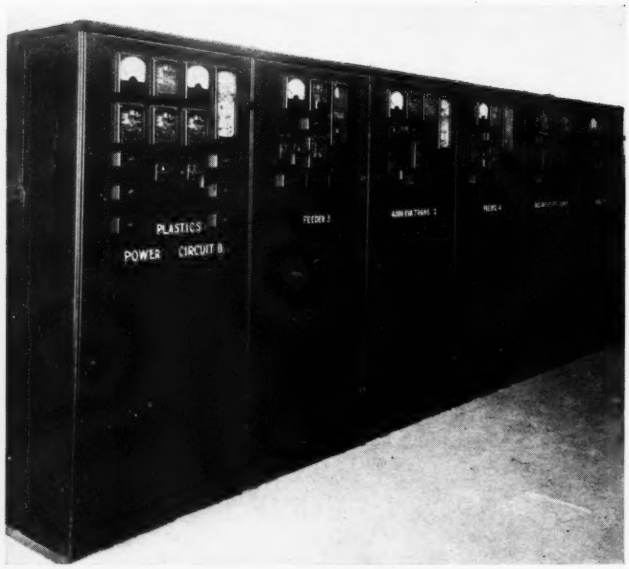


Fig. 2. (Above) Typical installation of the 13,800 v. breakers at the Pittsfield works

Fig. 3. (Left) The breaker unit in the operating position inside one of the cells

their breakers will safely clear a short circuit. With a knowledge of the constants of any given system it is possible to predetermine by calculation whether short circuit duties are within the ratings of installed breakers. Presentation of the complete information which would make it possible for the plant superintendent to make his own calculations would require many more pages than are allotted to this article. However, assistance in making the calculations can be obtained from the company with which the authors are associated.

In the study made at Pittsfield, the possible short circuit kv-a. was calculated for each substation bus and for each strategic load center throughout the plant. By means of these calculations, it was found that many new circuit breakers would be needed to properly protect the plant. Much has already been done to remedy the situation by replacing the old, slow-speed breakers with new, high interrupting capacity breakers of modern design installed in vertical lift metal-clad switchgear, with provision for easily removable and interchangeable breakers. The continuous current capacity of these breakers has been made high enough to care for a large increase in load, so that future expansion is already taken care of from a power supply viewpoint. The system on which the above study was made is 2300 v., 2-phase, 3-wire, 60-cycle.

A new double loop system operating on 13,800 v., 3-phase 3-wire has been completed within the past few months. This system and the 2-phase, 2300 v. system are tied together at the supply end through 3-phase to 2-phase transformers, but are otherwise independent systems. The breaker equipment used throughout this new 3-phase system is also of the high interrupting capacity, modern design installed in vertical lift metal-clad switchgear. An outline of these two systems showing the short circuit values encountered at substation buses and the types and ratings of breakers used might be of interest.

Figure 1 is a single line diagram of the plant's distribution system. Power is taken into the plant from the central station company's lines at 114,000 v.,

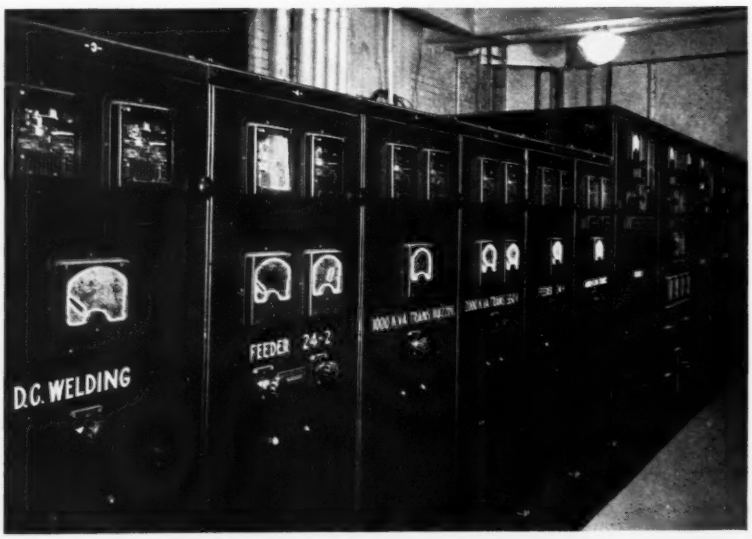


Fig. 4. An installation of the 2300 v. breakers

3-phase through two step-down transformers. One of these transformers is rated 10,000 kv-a. while the other one is rated 7500 kv-a. Each transformer has two secondary windings, one rated at 13,800 v., 3-phase; the other at 2300 v., 2-phase. Reference to Fig. 1 will show that the 13,800 v. circuit is carried to double bus in Substation 32, while the 2300 v. lines go to a double bus in the power house. These 2300 v. lines terminate at the sectionalized power house bus. Three 2-phase current limiting reactors rated 8.3 per cent at 5500 kv-a. are installed in these lines to reduce the short circuit values on the power house bus.

The two main power transformers mentioned above have reactances as follows:

10,000 kv-a. transformer

114,000 v., 3 phase to 13,-800 v., 3 phase..... 8.78%

114,000 v., 3 phase to 2300 v., 2 phase 10.2%

13,800 v., 3 phase to 2300 v., 2 phase..... 2.68%

7500 kv-a. transformer

114,000 v., 3 phase to 13,-800 v., 3 phase ..... 9.7 %

114,000 v., 3 phase to 2300 v., 2 phase 11.75%

13,800 v., 3 phase to 2300 v., 2 phase 3.36%

With these reactances and that of the lines, there is a possible short circuit value of 257,000 kv-a. at the 13,800 v. double bus, and 125,000 kv-a. at the 2300 v. double bus. The reactors reduce this last figure to 65,500 kv-a. as the power house bus. Figure 1 gives the short circuit values at several of the substation busses.

The figures for Substation No. 12 are somewhat higher than the other substations, due to the fact that this station supplies the large testing department using considerable rotating synchronous machinery. A short circuit on the busses would be fed from the synchronous machines as well as from the power supply. To protect the busses, which are 2300 v., vertical lift metal-clad breakers were installed having an interrupting capacity of 150,000 kv-a. All the new 2300 v. breakers installed to date are of this type. In the 13,-800 v. system the vertical lift type metal-clad breakers used have an interrupting capacity of 500,000 kv-a. Figure 2 shows a typical installation of these 13,800 v. breakers, while Fig. 3 shows the breaker unit in the operating position inside one of the cells. Figure 4 shows an installation of the 2300 v. breakers.

The selection of 500,000 kv-a., 13,800 v., and 150,000 kv-a., 2300 v. vertical lift, metal-clad oil circuit breakers to replace former inadequate switching equipment was dictated in this instance by local conditions. Air circuit breakers are now also available in these ratings and in other installations might be given preference over oil breakers.

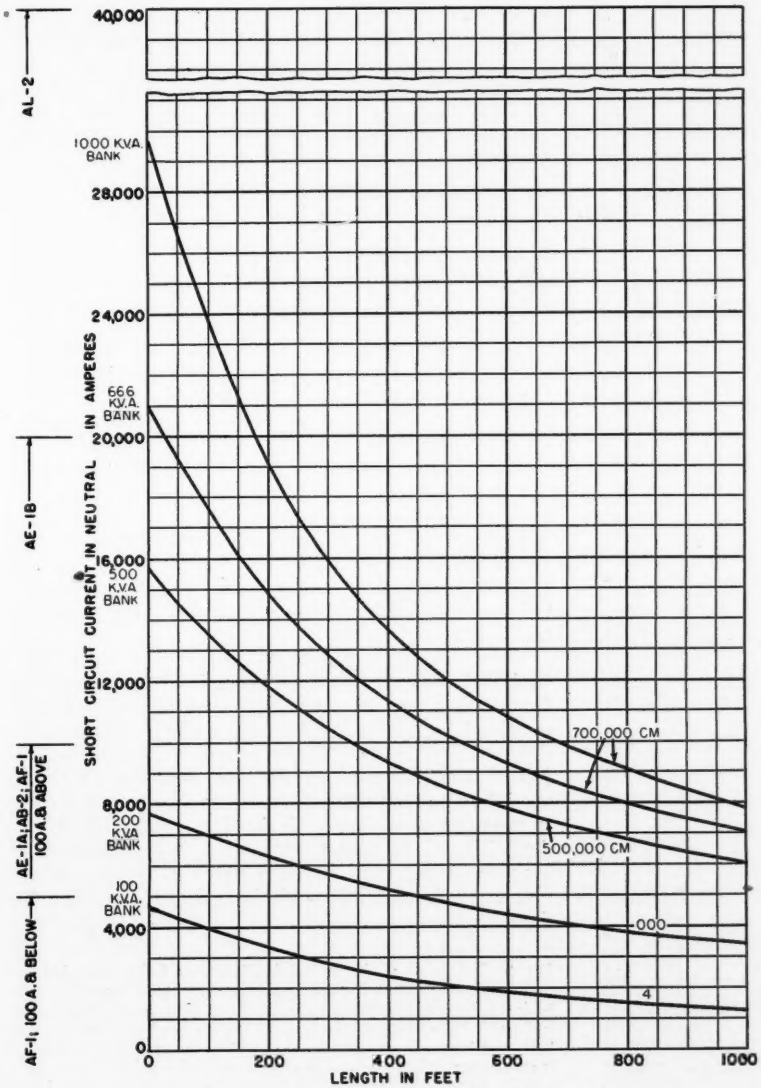


Fig. 5. Graph prepared by the Plant Engineering Dept. showing which type of breaker it uses to give adequate protection

System Protection

The recently installed 13,800 v. double loop system is amply protected against short circuits, grounds, and differential currents by a pilot wire system of relaying. The double loop assures the plant of continuous service by virtue of the fact that should a fault occur in any section of the loop, it would be automatically cut out of service and the balance of both loops would carry the plant. This is of supreme importance to a plant the size of the Pittsfield Works, as a shut-down from power loss is expensive and may very likely ruin materials in continuous processes.

After the present program is completed, the Pittsfield Works will be adequately protected against short circuits on any of its primary lines. With the large amount of power available to feed directly into a fault, this protection is essential.

(Continued on page 84)

FIG. 1

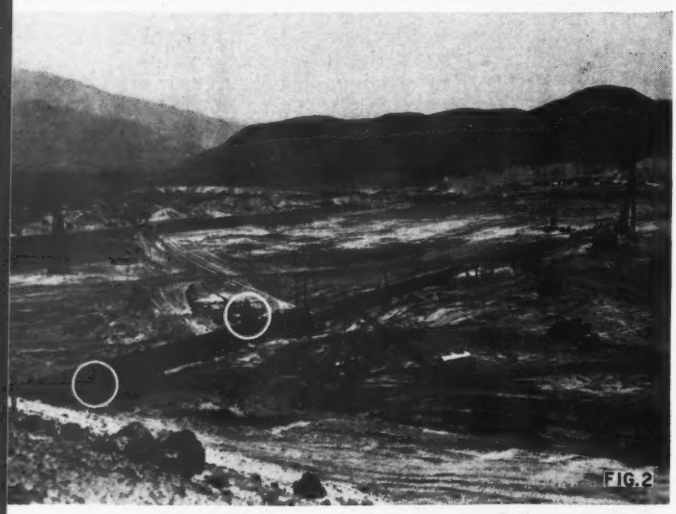
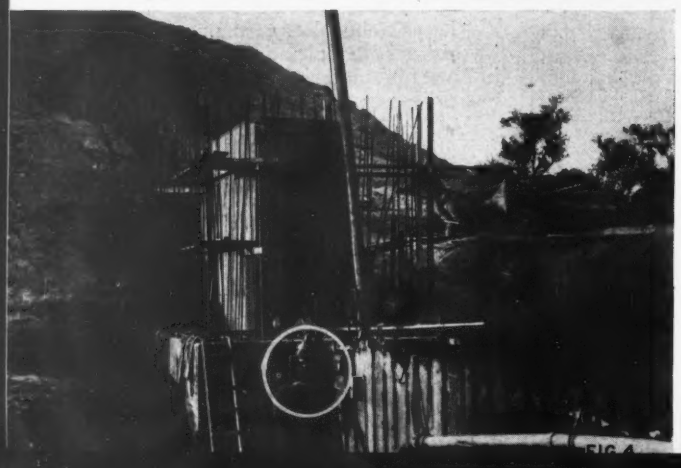


FIG. 2

FIG. 3



PRADO DAM

Unique applications of portable vertical pumps solve unusual ground water problems during construction

ONE OF THE major problems encountered in the construction of Prado Dam, across the Santa Ana River, 4 mi. west of Corona, Cal., was the handling of ground water. This was encountered from the first hours, when pits were dug for testing subsoil formations to the end of construction.

Prado Dam, sponsored by the Orange County Flood Control District, and constructed under the supervision of United States Army Engineers, has for its purpose the control of flood waters accumulating from the Santa Ana River water shed. It consists of a rolled earth fill with spillway and outlet works, having a crest line of 2280 ft., a base width of 850 ft., a maximum height of 105 ft., and a crest width of 30 ft.

It is capable of impounding 225,000 a.-ft., and eventually forming a lake covering 5 sq. mi., adequate to take care of a flood twice as severe as that encountered in 1937. Two 6 ft. gates are provided in the old river bed at the west abutment. These will ordinarily remain open at all times, but may be closed for storage in case of necessity.

The problem encountered in this case was not to furnish water, but to get rid of water, and to get the water to pumps so that it could be handled. Insofar as the gravel pit and the necessary dampening of the fill were concerned, there were definite water requirements in connection with both of them, but these were easy to estimate and solve by a pump engineer of experience. Chief difficulties lay in the handling of ground water encountered, as this was of course at variance from day to day, and in practically every single pump application, running from low intermittent at high heads to steady requirement at low heads. Thus the duty required of pumps on his job was necessarily through a great range, to say nothing of the solids carried, which generally ranged around 7 to 10 per cent of the volume pumped, and in some cases went up to as high as 25 per cent.

Vertical turbine pumps easily prove themselves to be the most efficient method of handling this dewatering problem, and replaced all other pumps on the job for the performance of this dewatering duty. The first of these pumps to come on the job was a 15 hp. short-coupled, multi-stage pump, used to dewater the caissons for the concrete piers supporting the Santa Fe bridge across the Santa Ana River. It was necessary to move more than 7 mi. of track and build a new bridge across the river, south and west of the selected site for the dam.

Fig. 1. Early view of the project looking toward the west abutment and showing an isolated pump in the foreground to lower the water table so excavation could proceed. Fig. 2. The sheet piling cut-off wall partially completed. General excavation has been carried about 2 ft. and in the foreground to about 15 ft. below the normal water level. Pumps on both sides of the piling are indicated by white circles. Fig. 3. Pump sling from a gibbet near the east abutment. Fig. 4. Close up view of pump near the west abutment showing sling and blocks used to facilitate lowering as excavation proceeded

A formation test pit, 10 by 20 ft., was decided upon, and sheet piling enclosing this space was driven to bed-rock approximately 70 ft. below the river bed. A pump was installed in a gravel-packed well adjacent to the location for the formation test pit, but due to the great amount of fine material in the sand, and the number of small clay layers throughout the formation, it was found that the well would not deliver in excess of 700 g.p.m. This was not enough to appreciably lower the ground water level. Next, a complete system of well points was installed, but this too proved to be ineffective because of these same layers of clay and their disposition throughout the entire formation.

It was then determined to dewater the test pit by means of a vertical multi-stage pump, hung on a sling in a sump, carried ahead of the pit excavation, while at the same time attempting to hold down the water level in the area immediately adjoining the test pit by means of another of these pumps hung on a tripod in a sump.

Use Extended

The satisfactory performance of these pumps in connection with the dewatering of the formation test pit and the adjacent area suggested their continued usage in connection with all excavation work. Formation tests indicated the necessity for bottom footings of the fill to be approximately 30 ft. below the river bed, over approximately one-third of the area of the dam site, and about 3 ft. below the river bed over the balance of the surface, save and except for that portion occupied by the cut-off curtain, where it was necessary to dewater to at least 9 ft. below the natural water table.

Therefore the second step in the dewatering process consisted of the installation of three turbine pumps, one on the down-stream toe near abutment, one on the up-stream toe near abutment, and one on the axis near the river. Shallow ditches were dug leading to these pumps which had been slung on tripods in sump holes with hose connections discharging down-stream. Through this method the ground water table was easily lowered from an elevation 457 to 455 ft. over the entire area of the dam site and surrounding countryside. Steel sheet piling was then driven along the axis of the dam to a depth of 70 ft. or to bed-rock.

Lowered in 6 Ft. Steps

Progressively then the excavation went forward over the entire area, with ditches and sumps being lowered in steps of approximately 6 ft., until the water table was reduced and held at proper level during the placement of the fill material. It was also necessary to hold ground water at least 10 ft. below the embankment surface, and this was accomplished by placing a perforated cell around the turbine pump and welding sections of 24 in. well casing around the column. As the fill was raised

FIG. 5

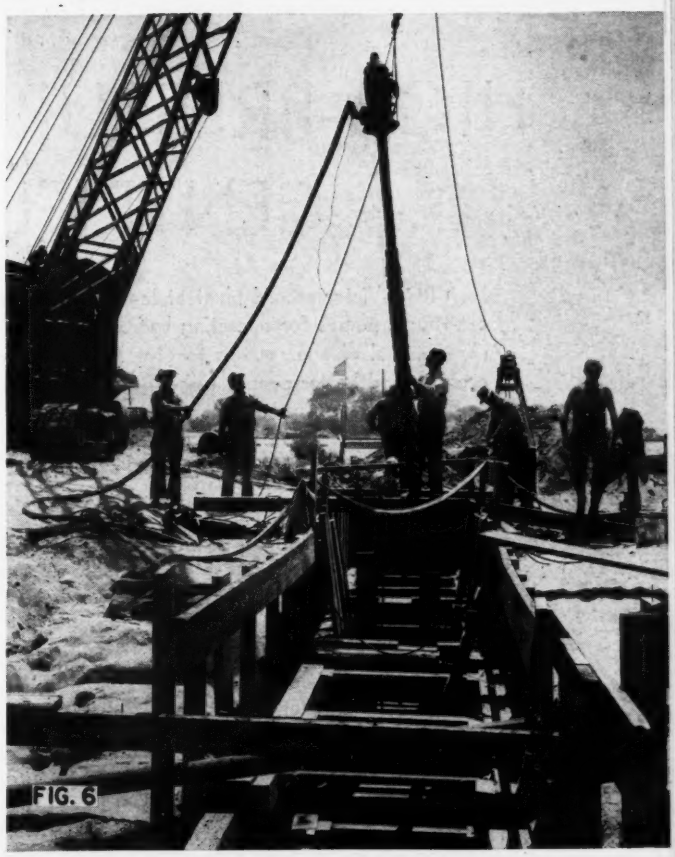


FIG. 6

FIG. 7

Fig. 5. Upstream and downstream crib cut-off walls were used with eight pumps in continuous operation while the concrete was being poured. Fig. 6. Due to the large amount of bracing in the trench only a compact pump could be used. This shows the method of handling a typical pump. Fig. 7. Typical tripod pump installation used in sumps during the construction period. This particular pump is in the upstream toe trench, but the photograph was taken after completion of the work with the pump shut down and the water at its natural level. All together 16 pumps ranging in size from 2 to 30 hp. were used

2 ft., an additional 2 ft. section of casing was added to the column. When water reached the natural level, cells were filled with concrete.

In dewatering the crib trenches the water inflow was not great, but was constant. With a limited space in which to work, the vertical turbine pump again solved the problem by suspending the pump in a sling or on a block and fall, with hose connections both to intake and discharge. This method of dewatering was found to be much preferable to the old-style pulsometer or mine sinker type of plunger pump.

Down-stream and up-stream walls of the crib cut-off are 830 ft. long and 6 ft. thick. The web walls are 38 ft. long and are set on 30-ft. centers between the stream walls. These walls were carried down to bed-rock. In pumping out water for the excavation of the up-stream wall, it was necessary to start the pump at a depth of about 20 ft. from the top of the wall and to continue it down until excavation had been completed and the concrete had been poured. Concrete was poured in pockets 30 by 38 ft. at a time, pumps were moved in successive stages along the wall from one to the other pit, using pumps both ahead of and behind concreting operations, in order to keep excavation trenches dry and workable.

Sixteen Pomona pumps, ranging in size from 2 to 30 hp., in head from 60 to 150 ft., and having a combined capacity of 15,000 g. p. m., were used from first to last on this dewatering operation. They were adaptable to the job in hand, and the low cost of maintenance was quite remarkable in view of the amount of solids handled. Only one pump man was required, in spite of the fact that during a large percentage of the time that the dam was under construction the majority of the pumps were in operation both day and night.

HIGH-PRESSURE CENTRIFUGALS

New RCA-Victor record plant at Indianapolis uses 1800 lb. vertical centrifugal pumps for operating hydraulic presses, a departure from conventional plunger pumps to give lower costs and more uniform pressure and better control without using accumulators. New power plant also built

DURING THE past year the RCA Manufacturing Co. constructed at its Indianapolis plant a one story ground floor building of 102,000 sq. ft. devoted exclusively to the manufacture of Victrola records. Electric power is purchased but a new boiler room was added at the same time to more efficiently take care of the space heating and carry the increased process load more efficiently.

One of the most interesting features of the new plant is the application of centrifugal pumps for operating the hydraulic presses on which the records are made. Presumably this is the first departure for such work from the usual plunger pump. It was made in an effort to reduce first cost, simplify the installation, give better control and more uniform pressure without resorting to an accumulator.

Two Byron Jackson 23 stage Hydropress vertical centrifugal pumps are installed, each with a capacity of 120 g.p.m. at 1800 lb. pressure. This type of pump, shown by Fig. 1, built in a range of sizes from 10 to 250 g.p.m. and for pressures as high as 2800 lb., has found a wide application for such varied services as lifting water 3700 ft. from the Grand Canyon, unwatering mines, repressuring oil wells and hot oil refinery service.

The construction is unusual and simple. The impellers are arranged so as to give hydraulic balance and the volutes, without guide vanes, are cast in two halves. These halves are put together (with the shaft and impeller assembled) and inserted in an electric welded outer barrel. The faces between the halves are ground but no gasket is used, for the outer surface is subjected to the discharge pressure which keeps the joint closed without distortion of the castings.

The only stuffing box is at the suction end and seals against low pressure. It is incorporated in the casting with the suction and discharge nozzles. When the joint between this casting and the barrel is broken, the two halves and impeller can be lifted out and opened like a book to expose the rotating elements. In effect it is much like a banana slipped from the skin and split longitudinally with a knife.

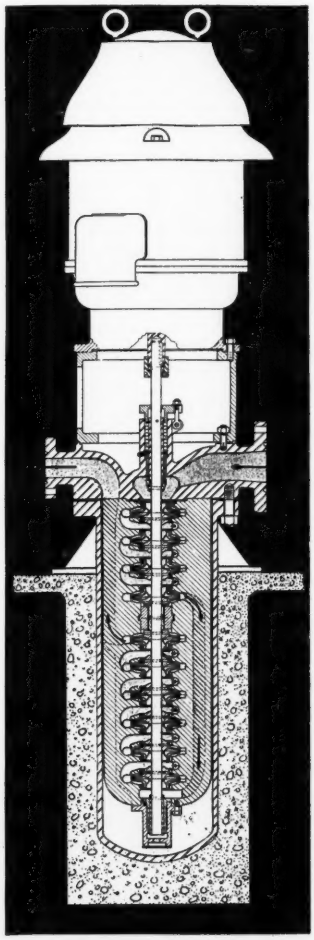


Fig. 1. Type of pump used for high pressure. Two of these are installed each with a capacity of 120 g.p.m. at 1800 lb. pressure

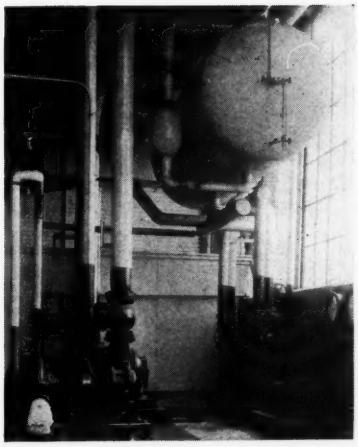


Fig. 2. The hot water receiver in the boiler room with the boiler make up pumps directly below and the record water circulators at the left. The water temperature is maintained constant at the discharge of the circulators by a regulator which controls the flow of hot water from the receiver to the suction of the pumps. The balance of the water pumped is taken from the cold sump

In making a record, the plastic "biscuit" which looks much like an asbestos shingle about 5 by 7 in. is first heated on a plate adjacent to the press and warmed by 135 lb. steam. When soft the biscuit is put in the press between the two dies. The press is held closed by a hydraulic cylinder supplied with water at 1800 lb. pressure.

As the press is closed a system of valves runs automatically through its cycle, first heating the press, then cooling it and finally releasing the pressure. About 5 gal. of water is required for each record, about one quart of this being at 1800 lb. Some of this water is reclaimed but a portion is rejected to the sewer in order to maintain the temperatures required in different parts of the system.

Initially the water used comes from deepwells pumped by two Layne & Bowler deepwell pumps, its temperature throughout the year being constant at 54 deg. F. This water is stored in an underground 36,000 gal. tank which is connected to the power plant sump by a tunnel. The well water is high in carbonate hardness and is first taken through a Spaulding Precipitator cold lime softener and treated for the removal of sufficient calcium carbonate to prevent encrustation of the pipe lines on the press floor.

Circulating water for the presses is supplied at 140 lb. pressure, 62 deg. F. by two Allis-Chalmers 450 g.p.m. pumps. These pumps take their suction both from the sump and from an overhead hot water receiver. The bypass from the receiver being controlled by a Powers regulator so as to give a final temperature of 62 deg. F. at the pump discharge. Hot water from this receiver is also used for boiler feed makeup, two American Marsh 80 ft., 40 g.p.m. pumps being used to deliver the makeup to the feedwater heater. In emergencies a 175 g.p.m. Chicago pump can be used to deliver cold water direct from the sump to the feedwater heater.

This water at 140 lb. pressure is pumped to the record room, to be used on the presses, and, under control of a float valve, as makeup for the sump from which the Hydropress pumps take their suction through an Elliott twin strainer.

The two Hydropress pumps (each driven by a G.E. 200 hp., 3550 r.p.m. motor), one Chicago sump pump and the two receivers are in a pump pit in one corner of the press room. Each receiver has two Chicago pumps (each with a McAlear strainer in the suction) which pump back to the elevated receiving tank in the boiler room and are shown by Fig. 2. Returns in excess of the capacity of the tank are bypassed to the sump by a Powers controller.

In the boiler room are installed 3 Keeler, Type CP, 250 hp., boilers without superheaters, designed for 200 lb. but operated at 135 lb. ga., the pressure set by process requirements. These boilers are fired by Riley Riflex stokers, the arrangement being well shown by Fig. 3. Between the two boilers are installed the auxiliaries, namely an International lime and soda ash softener and heater, and two American Marsh boiler feed pumps, one 7½ by 4 by 10 horizontal duplex and one centrifugal driven by a 20 hp., 3460 r.p.m. G.E. motor.

The boilers are equipped with Cash combustion control, Fisher pump governors, Yarway blowoff valves, Diamond sootblowers, Reliance gage columns, Foxboro temperature recorders and Consolidated safety valves. At the present time an Indiana 5th vein, 1¼ in. screening is being used.

Design of the plant was handled by the engineering department of the RCA Manufacturing Co., Camden, N. J., under the direction of Theodore Wachs, Plant Engineer. J. A. Drogue is Plant Engineer of the Indianapolis plant.

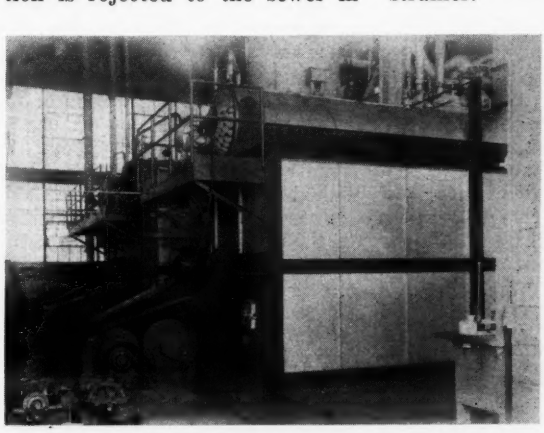


Fig. 3. The new boiler room has 3 stoker fired boilers. Stoker hoppers are filled by shovels from a storage bin at the left. Auxiliaries are located between the two boilers

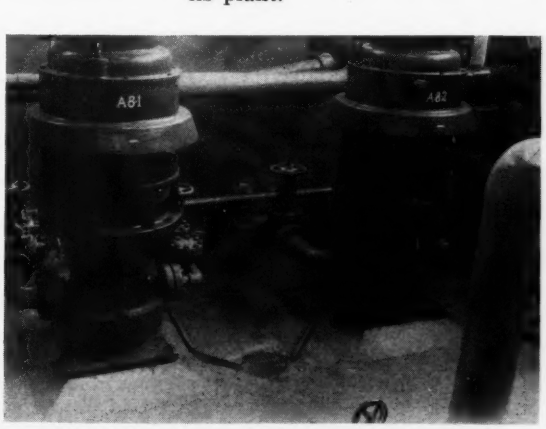


Fig. 4. The two high pressure pumps 120 g.p.m. each at 1800 lb. pressure are installed in a pump pit in the record room. In this same pit are: 2 sump pumps and two receivers, for heating and press water, each with two pumps for returning the water to the receiver in the boiler room

Over 1900 members and guests attended the Annual Winter Convention of the American Institute of Electrical Engineers held at the Bellevue-Stratford in Philadelphia, January 27 to 31. It had one of the largest technical programs in years

ELECTRICITY MOVES FAST

LACK OF PREVIOUS experience in running A.I.E.E. winter conventions proved no handicap to the Philadelphians who, this year for the first time in the history of the Institute, had the Winter Convention of the American Institute of Electrical Engineers in their city. It had been an unbroken custom for many years to hold this most important of all A.I.E.E. yearly events in New York City, but this year precedent was broken and the meeting held in Philadelphia instead. The Philadelphians proved most excellent hosts and the Bellevue-Stratford Hotel was the scene of most intense activity both social and technical the entire week of January 27.

It is well known that electricity moves fast, the 186,000 mi. per sec. is almost a commonplace, yet one must attend one of these winter meetings to really find out how fast it does move. In many ways these winter conventions constitute a measure, a yardstick, by which progress in the electrical art is measured. Many of the great developments in the field of electricity have been first formally announced or demonstrated at past winter conventions. Transcontinental and trans-atlantic telephony, for example, were both first demonstrated at winter conventions. The principle of deionization which has played so important a part in the development of circuit interrupting devices in recent years, was first described before one of the winter conventions of the A.I.E.E. The Black feedback amplifier which has revolutionized amplifier and communication transmission technique was first presented in a paper before an A.I.E.E. winter meeting. Many other examples could be mentioned but these will suffice.

This convention just past was no exception in this respect. Several remarkable new developments were described, the most notable perhaps being the electron microscope. This astonishing device which has a resolving power some twenty times that of the most refined optical microscopes is destined to play an important part in the development of man's future knowledge. An outgrowth of high frequency and television technique, it places in the hands of the scientists a most remarkable tool, one which potentially is capable of "seeing" molecules.

This convention also was noteworthy for its emphasis upon the co-ordination of electrical science with the biological sciences and the field of medicine. One of the most interesting sessions held was one at which doctors of medicine and doctors of engineering participated in discussing their mutual problems with respect to recent electrical discoveries and developments. It was something of an event to find doctors (M.D.'s) and electrical scientists discussing terms of mutual understanding on common ground.

Those who attended the general session on Wednesday morning, January 29, will long remember the fascinating address by Professor Robley Evans of M.I.T. on the implications of atom smashing technique in the field of biology. No prestidigitator or other popular purveyor of hocus pocus ever held an audience more spellbound than did Professor Evans with his curious array of atom models and Narcissus plants. Whatever doubts one may have entertained regarding the practical application of the score of cyclotrons now in use or being constructed throughout the country, they were quickly dispelled by Dr. Evans' remarkable demonstration of the tracer method in the use of isotopes in metabolism studies. If used for no other purpose than this, the cyclotrons will prove their worth many times over.

In a brief report such as this it is impossible even to mention the many technical papers presented at this convention, nor would it be desirable if space permitted. As in all technical gatherings of this character, many of the papers are of such specialized interest as to be of value only to

those whose work lies in those respective fields. In the field of power transmission, for example, the question of relays has grown so complex that, to one not versed in modern aspects of the relay art, a paper on the subject of relaying is quite likely to be as baffling as an Agatha Christy murder mystery.

Almost Human Relays

As an example of what is being accomplished in relay development, consider a device which goes by the curious name of the harmonic restraint relay. As described by C. D. Hayward of the General Electric Co., this relay has the ability to distinguish between apparent fault currents caused by transient inrush and real fault currents due to, say, a transformer failure. Relatively high currents called "inrush currents" flow through transformer windings for short times when transformers are connected into a circuit. These inrush currents may prove troublesome since they frequently act to cause unnecessary tripping of protective relays. The harmonic restraint relay is designed to prevent this.

System Stability

Of considerable importance to power engineers were two sessions devoted to Power Generation. All of the seven papers presented at these two sessions were devoted to the problem of governing and maintaining system stability. As pointed out by W. L. Cisler, the chairman at these sessions, the growing defense needs emphasize the importance of system control and stability.

The first paper at this session was one dealing with prime-mover speed governors for interconnected systems by R. J. Caughey and J. B. McClure of the General Electric Co. In this paper they showed that system operating requirements from the standpoint of frequency and tie line loading are continually becoming more rigorous. While supplementary governors have been developed, the speed governors of the prime movers still constitute the backbone of system control. The paper outlined the problems encountered and presented conclusions regarding the necessary characteristics for prime mover governors on large systems.

This paper was followed by one on "Power System Governing" by J. J. Daugherty and A. P. Hayward of the Duquesne Light Co. and A. C. Montieth and S. B. Griscom, both of Westinghouse. This paper, dealing with the problem of power system governing, was based upon answers to a questionnaire submitted to a representative group of operating companies.

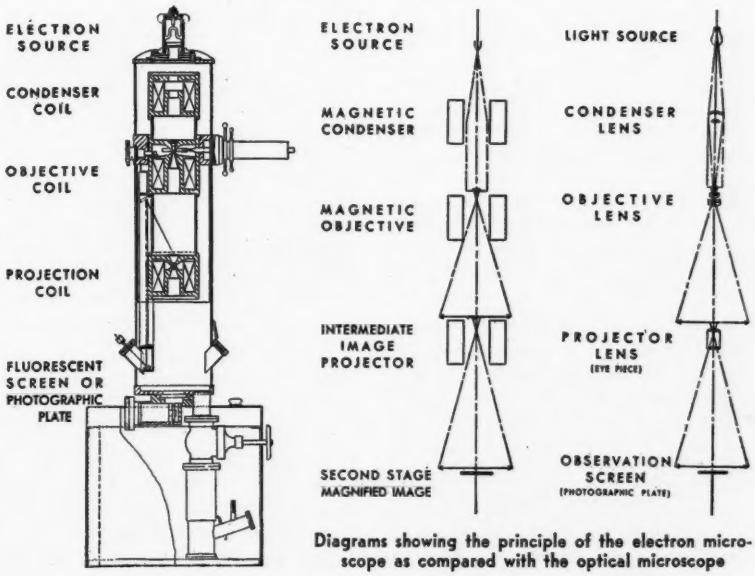
The problem of maintaining stability on a large interconnected system is necessarily complex and in a group discussion of this kind where specialists in various branches of the art present their particular viewpoints, the problem as a whole is likely to be dimmed by the concentrated attention to detail. It was refreshing and instructive, therefore, during the discussion of these papers to have Dr. Gutenberg of Harvard University go to the blackboard and in a brief five-minute talk present a beautifully clear picture of the whole problem of system stability in terms that even a layman could understand. By means of a simple one-line diagram of an interconnected electro-mechanical system and a few wave diagrams he was able to explain the two types of oscillations that characterized such a system. Dr. Gutenberg's discussion was brief but, as he pointed out, was essentially the substance of a more comprehensive paper he had published some years before in Germany. It served to co-ordinate and make more intelligible all the other papers presented at these particular sessions.

The industrial power plant engineer's relation to the question of stability was injected into the discussion by Mr. Kramer of the Carnegie-Illinois Steel Co. In industrial plants the problem of stability is one that involves the boiler capacity of a generating plant more than turbine governor design. In a steel plant running at a normal load of around 30,000 kw., Mr. Kramer said that the sudden starting up of 2 or 3 strip mills would raise the load to 50,000 kw. in a few seconds. Under such conditions, he said, governing does not help because the turbine suddenly draws all the steam out of the boilers—they suddenly are called upon for an additional 150,000 lb. of steam.

250,000 kv-a. Air Circuit Breakers

In view of recent developments there was naturally considerable interest in the new types of both high and low voltage air circuit breakers. Papers on air circuit breakers were presented by both General Electric and Westinghouse engineers. Among these was an interesting paper by E. W. Boehne of General Electric on the "Geometry of Arc Interruptions". Applicable to the analysis of any type of interrupting phenomena, Mr. Boehne's paper showed by mathematical analysis how simple, straightforward principles of circuit analysis can be applied to the computation of arc current, arc wattage, and recovery voltage to show the unappreciated advantages of high values of arc voltage throughout the brief arcing period to create ideal interrupting conditions.

Mr. Boehne also told how a zero power factor circuit can be so modified by arc voltage as to cause the interrupting current zero to ar-



Diagrams showing the principle of the electron microscope as compared with the optical microscope

G. E. Stoltz talks things over with Prof. E. E. Dreese, Electrical Engineering Dept., Ohio State University

Photo, Westinghouse

rive simultaneously with, or even slightly ahead of, the zero point of the circuit voltage. This leading power factor effect, he said, had been achieved in the "magne-blast" breaker and it has made possible the development of a 250,000 kv-a., 7500 v. breaker.

Mathematically enhanced diffusion of ionized particles, as was shown by R. C. Dickinson and R. H. Nau of Westinghouse was also the basis of a new 250,000 kv-a. air circuit breaker recently developed by Westinghouse. In a paper describing this breaker the interrupter was shown to consist essentially of an arc chamber of laterally spaced refractory plates and a magnetic circuit imposing an intense magnetic field transverse to the slotted plates during the arcing period.

In the discussion of this subject, Joseph Slepian and R. H. Nau of Westinghouse took issue with Boehne regarding the representation of arc energy in the latter's paper. Dr. Slepian said he preferred to aim for low arc energy because it is not readily possible to obtain low arc energy in magnetic acceleration of interruption. Mr. Nau in closing the discussion cited a 10 to 12 in. arc length in the Deion (Westinghouse) pattern against a value as high as 36 in. in the Magne-Blast (General Electric).

In view of the parallel lines of development in the circuit breaker art by competing manufacturers, it is refreshing to have these differing viewpoints because such difference of opinion keeps the art from becoming stagnant.

Electric Shock

Unusual, yet curiously interesting, was the paper on Electric Shock by C. F. Dalziel, Dr. John B. Lagen and J. L. Thurston all of the University of California. It is somewhat of a paradox when one stops to consider that for all the electrical engineer's study into the nature of electricity and its various effects, he has done very little in studying its effect upon the human body. As pointed out by the authors of this paper, a review of the existing literature reveals very little information regarding the effects of small 60 cycle currents on man. These currents are not sufficient to cause unconsciousness or death but they are sufficient to produce involuntary muscular contractions.

The report given in this paper is based on experiments made on 120 men. The main object of the investigation was to determine the "let-go" currents of a large number of subjects. Of the 114 men tested on 60 cycle alternating current, the average let-go current was 15.5 milliamperes and the highest was 21.6 milliamperes. The threshold of perception was determined for direct current and commercial 60 cycle alternating current. The 60 cycle threshold current for 115 men was 1.1 milliamperes average, 0.4 milliampere minimum, 4.0 milliamperes maximum. The threshold of perception for direct current for these 115 men was 5.2 milliamperes average, 2.2 milliamperes minimum, 12.6 milliamperes maximum.

All the interesting facts learned in this investigation cannot be recounted here but it should be of interest to everyone to know that they were made and that the results are available. The paper evoked excellent discussion and in view of the growing use of electric fences by farmers, was a timely presentation. Mr. Lloyd of the Bureau of Standards commented on this development and pointed out that many persons had been killed by such fences, mostly by those of the home made variety.

Broadcast Program Transmission Over Wire Lines

The latest developments in the communication field were presented at two sessions, one special session held in Town Hall at 150 N. Broad St. several blocks from the Bellevue-Stratford Hotel, the convention headquarters. The reason for this was a special demonstration of the performance of high quality telephone transmission circuits of the type used for radio program transmission. This demonstration involved the transmission of the music of the Philadelphia Symphony Orchestra in rehearsal at the Academy several blocks away to the assembled audience in Town Hall. First the music was transmitted directly over a circuit about two blocks long between the Academy and Town Hall, then for the sake of comparison, it was switched to travel over a circuit some 1400 miles long. It is a fine tribute to the skill and technique of the communicating engineer to recount the fact that these two transmissions, and also that the electrically reproduced music in Town Hall was the same in tonal range, in volume and in gradation as that originating in the Academy.

At this same session in Town Hall, M. E. Strieby and J. F. Wentz of the Bell Telephone Laboratories presented a paper on the transmission of television programs over wire circuits. This paper described recent experiments in the transmission of 441 line 30 frame interlaced television images over lines of a type that may be useful in providing local and intercity networks for television broadcasting. It includes a coaxial type of line system which appears suitable for long intercity connections, and also various connections for short distance video transmission better suited to intracity use. The development of these lines represents an important step in the progress of television technique and brings commercial television a step closer.

The television transmission system referred to in the preceding paragraph was designed to operate at frequencies of the order of 50 megacycles. Contrasting with these high frequencies was the circuit described in another paper pre-

sented at this session which was characterized by the use of frequencies as low as 1/25th of a cycle. This was a circuit used to transmit pictures (facsimile) by submarine cable. The paper was presented by J. W. Milnor of the Western Union Telegraph Co. This new and more efficient system for the transmission of facsimile matter from London to New York by submarine cable was made available for public service in April 1939. As disclosed in this presentation the direct transmission of pictorial matter over transatlantic submarine cable has become practical through the development of some very special types of network and amplifiers.

The Electron Microscope

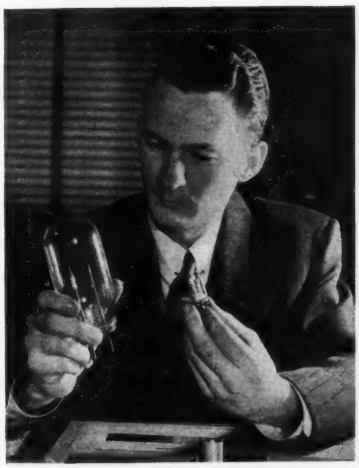
Perhaps the most important of all recent developments described at this convention was the electron microscope. This remarkable device was discussed in a paper by V. K. Zworykin, J. Hillier and A. W. Vance, all of R.C.A. Manufacturing Co., Inc. The electron microscope is an outgrowth of the television art and represents the most important advance in microscopy since the optical microscope was invented. With one stroke, this development raises the possible magnification from a maximum of 3000 with the optical microscope to an easy 100,000 or even 150,000. In principle the electron microscope is the same as the optical microscope but instead of a beam of light it employs a beam of high velocity electrons, and instead of glass or quartz lenses as in the case of the optical microscope, the electron microscope uses magnetic lenses. The enormous resolving power of this new device opens up completely new fields of research in physics, biology, chemistry and mineralogy.

The electron microscope was one of the three developments discussed at a conference on new electrical aids for biological and medical research. The other developments considered at this conference were the high voltage X-ray and the cyclotron. It was at this conference that medical men and electrical men met on common ground to discuss the uses of these new developments. In many ways it formed one of the most interesting and perhaps one of the most valuable aspects of the convention.

Dr. Robley Evans' lecture on atom smashing and its application to medicine has already been mentioned but it deserves further comment because in many ways the developments he described will be of greater importance to humanity than any other subjects discussed at this convention.

Fundamentally, his lecture discussed the use of artificial radioactive isotopes in studying metabolism in living organisms. One of the most recent important discoveries in science has been the method of producing temporary radioactivity in non-radioactive elements and substances. By bombarding common substances with high speed atomic particles, protons, neutrons, alpha particles, etc., it is possible to render a substance such as for example, common salt or iodine, radioactive for a short period of time. The period will vary from a few seconds or minutes to several days but during that time the material exhibits all the characteristics of spontaneous disintegration normally found in radium or uranium.

It is in this process of creating this temporary radioactivity that the many cyclotrons now in use in the university laboratories of this country are so useful. For these wonderful machines with their remarkable capacity for producing high speed streams of particles can create a condition of temporary radioactivity in any ordinary substance.



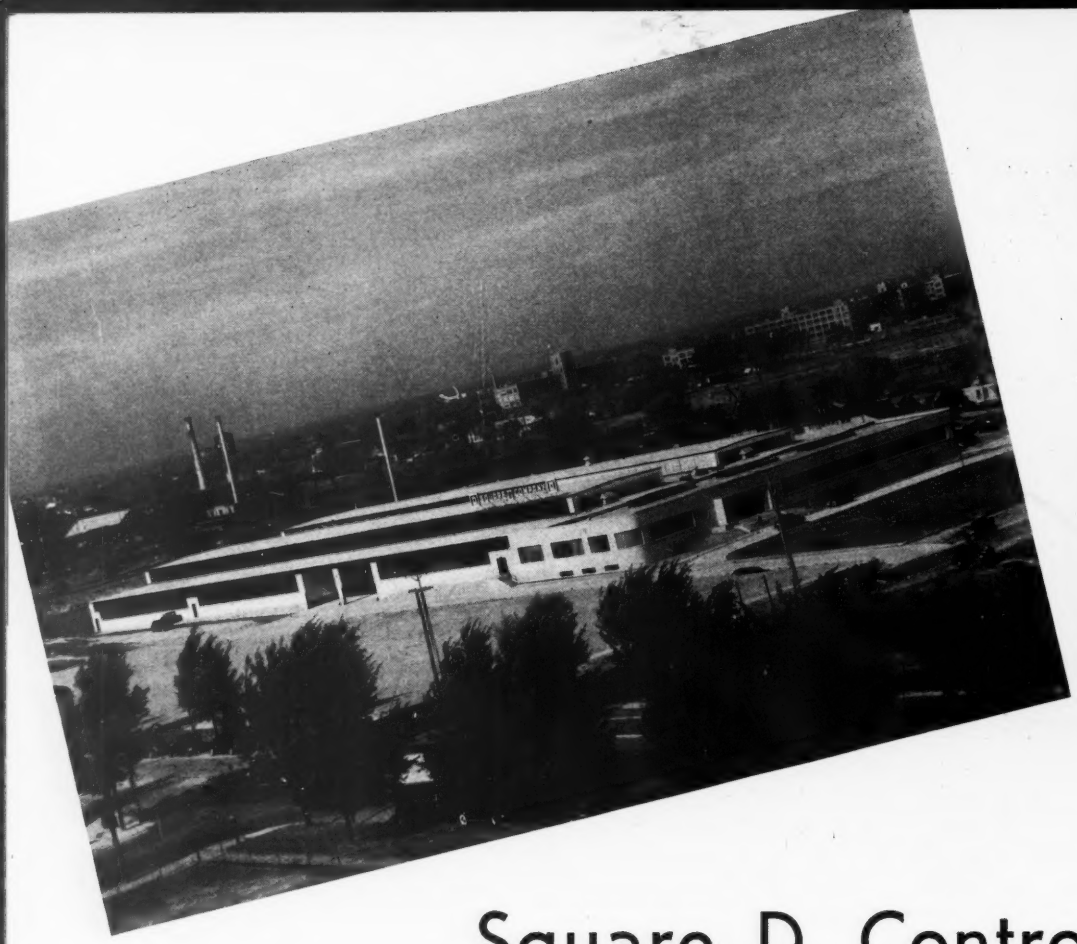
The interesting story of the development of the glow switch was told by R. F. Hayes (Westinghouse) at the convention. Here he compares a large model of the switch used to demonstrate its operation in starting fluorescent lamps with the commercial unit

Suppose now, that a small dose of such artificially radioactive iodine is fed to a patient suffering from a thyroid ailment. In accordance with well established principles some of the iodine atoms—the radioactive ones—some time in the course of the following 24 or 48 hours will undergo a sudden change in their nuclear structure. They will suddenly shoot out an electron, or a proton, or an alpha particle (the helium nucleus). The emission of such particles is easily detected by means of a sensitive instrument known as the Geiger Counter. Hence, it is necessary only to hold the Geiger Counter near the thyroid gland of the patient to determine whether and how many of the radioactive iodine molecules went into the thyroid. In the same way the number that went into the fingers or toes can be determined. In the same way the course of calcium can be traced in its passage through the body.

Dr. Evans demonstrated the technique in a beautiful way with two Narcissus plants each in a small flower pot. One of the plants had been given a dose of a radioactive ammonia compound 24 hours before, just at the time when the plant was about to blossom. It was interesting to see how, when the Geiger Counter was moved up and down the stem, nearly all of the radioactivity was lodged in the blossom. It was there that the nutrient ammonia compound was needed in the process of bringing forth the blossom.

The foregoing presents only a few highlights of this important convention. There were dozens of other interesting papers—papers on fluorescent lighting, on electrical transportation, on industrial plant power distribution, on electronics, on cable design, etc., which cannot even be mentioned here. There were inspection visits to the General Electric Co., Westinghouse, I-T-E Circuit Breaker Co. factories, to generating stations, to the Philadelphia Mint and many other points of interest. At the Edison Medal Presentation on Wednesday night, the Edison Medal was presented to Dr. George A. Campbell, retired research engineer of the Bell Telephone Laboratories and at this meeting Charles E. Wilson, President of the General Electric Co., gave an address, "After the Defense Program—A Challenge."

The convention was unusually well attended, total registration being over 1900.



Square D Controller Division In New Milwaukee

THE SQUARE D COMPANY has transferred its Milwaukee offices and all production of the Industrial Controller Division to a new 125,000 sq. ft. plant on North Richards Street at Capitol Drive, where production capacity has been increased 50 per cent.

A modern power distribution system which utilizes the company's own products to provide the highest possible degree of flexibility and efficiency is one outstanding feature of the new plant, which was designed and built by The Austin Company. The manufacturing area, laid out for straight-line production in two 60 ft. monitor bays and three 40 ft. low bays with columns on 40 ft. centers lengthwise of the building, extends a distance of 380 ft. beyond the offices.

Buff face brick and limestone have been combined in curves and angles with continuous projected steel sash to provide an impressive modern facade across the streamlined office section. The offices are air-conditioned and equipped with indirect lighting fixtures and skylights having concealed bulbs which are turned on by an electric eye to insure a minimum of 35 foot-candles at desk level when natural light falls below a given intensity. A basement extending under the entire office section will be utilized as a cafeteria for employees and for the storage of files and records.

Forty-two hundred lineal feet of square-duct has been used throughout the structure, including 500 ft. in the office building where one installation serves the telephone system and another the lighting connections and office equipment.

Feeder lines which enter the plant through a dead front service distribution switchboard are accommodated in concrete underfloor trenches which have been designed with slope to provide drainage for any possible condensation. Fibre conduit has been used in these trenches which follow the line of columns and have service connections that turn up to distribution panels on each column in the main aisles. Maintenance is expedited by four manholes located at the junction points where the feeder lines branch off in two directions from a main trench which extends south across the plant from an outdoor sub-station where 13,000 v., 3 phase primary is transformed to 240, 3-phase power and 115/230 v. lighting.

Use of the square-duct simplified distribution of power to more than 275 individual motor-driven machines. The ducts are at a uniform height of 13 ft., so located that in no instance is the distance from the duct to any individual motor more than 25 ft., which makes it possible to hold the size of copper required to one-third the size of the main cable.

With all of the square-duct equally distant from the plant floor, the changing of connections will be a simple matter in case of plant expansion or any other situation which would make it necessary to relocate equipment. One 350 ft. run of 2½ in. square-duct has been installed in the 40 ft.

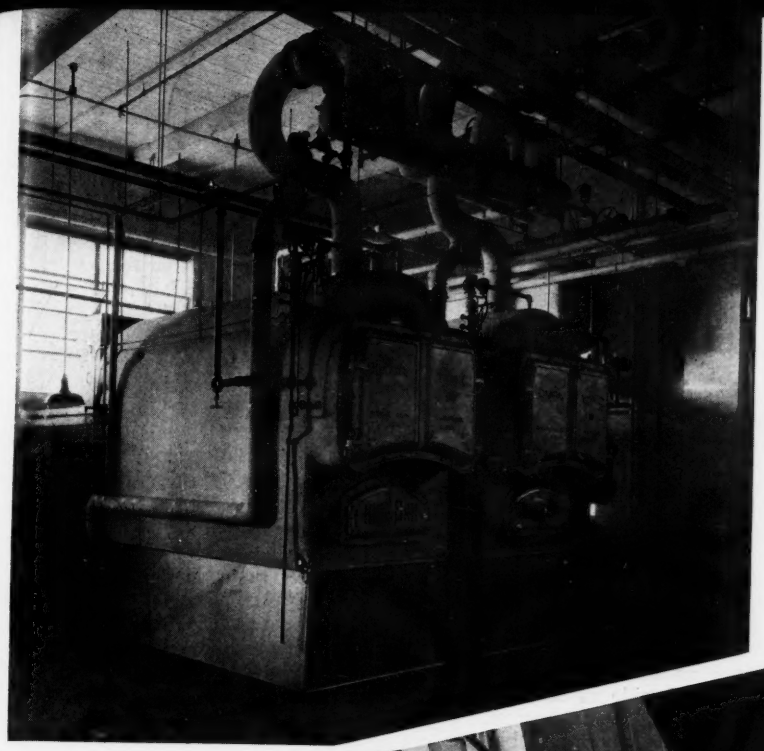
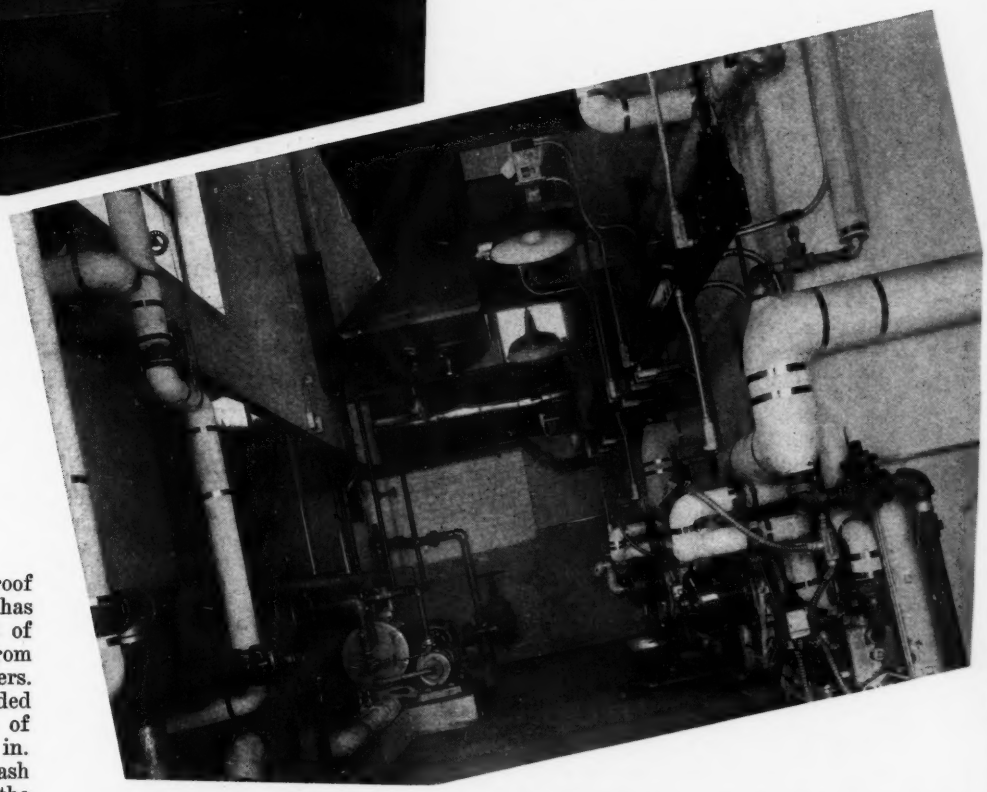


Fig. 1. Extreme left. An exterior view of the new 125,000 sq. ft. Square D plant

Fig. 2. Left. Two completely automatic oil fired boilers meet all heating requirements while a third 35 hp. boiler is provided for hot water and process steam

Fig. 3. Below. A 4-in. square duct on 3 sides of this areaway between boilers have precluded the necessity for a maze of conduit which would have reduced accessibility of the equipment



Plant

center bay, where it rests on roof beams. Four inch square-duct has been used throughout the rest of installation and is suspended from the roof by universal drop hangers.

Generous daylight is provided through the 6 ft. 7 in. runs of monitor sash and 10 ft. 3½ in. runs of continuous side wall sash which completely surround the plant, while from 25 to 35 foot-candles of light is provided for night work by 500 w. Mazda lamps in standard RLM reflectors on 12x13 ft. centers. Vapor-proof fixtures are used in the enameling shop.

Thermostatically-controlled ceiling projection type unit heaters at 17 locations throughout the plant have a combined heating capacity of 5,638,000 B.t.u. and a blower capacity of 82,300 c.f.m. and are served by two completely automatic oil burning boilers with an

Fig. 4. Right. Punch presses concentrated at the rear of the new plant are motor driven and are served directly from square duct which has been used for power distribution

S.H.B.I. steam rating of 18,220 sq. ft. each. A separate oil fired boiler for process steam, rated at about 35 hp., meets the year-round requirements for hot water and process steam. Wiring for all electrical controls serving the automatic boiler equipment is carried in 4 in. square-duct, which eliminated the need for a maze of rigid steel conduit and provides ready access to all of the motors and control units that have been compactly nested behind the boilers. Oil for boiler operation is stored in two 10,000 gal. tanks underground, which are connected to the building through a 30 ft. concrete pipe tunnel, 7 ft. wide. This is covered with planking and dirt. The oil is preheated for efficient combustion in a converter through which hot water and steam return lines pass.

Two air conditioning units, each of 9000 c.f.m. capacity, serving the office section are situated alongside the wall which separates plant and office areas, and deliver conditioned air to the office by means of anemostats. They use water pumped from a deep well at 50 deg. F. for cooling. After it passes through the sprays in the air-conditioning chamber, this water is pumped to a standing pond on the office roof which substantially reduces the cooling load in summer. It overflows from the roof to pipes connecting with the lawn sprinkler system and is used for this purpose or wasted to sewers.

The plant has been laid out with a view to efficient production and in anticipation of the departmental expansion which would be required by future extensions. Wide column spacing was facilitated by the use of welded trusses used throughout the building. Incoming materials are received over a siding on the north side of the plant at the rear, directly adjacent to the boiler room, so that any type of fuel which might be used would be easily handled.

Steel for use in the manufacture of controller cabinets, switchboards and other equipment, is stored directly adjacent to the receiving dock, at a point also accessible for unloading of steel received by truck. Production departments have been located with a view to minimum handling so that steel can move directly from storage to press and cabinet departments and then to the assembly departments which are adjacent to the coil winding and inspection area.

Other materials and small assembly parts are concentrated in a special storage department convenient to the coil winding and assembly area, while miscellaneous stock is concentrated under a mezzanine area devoted to employee toilets and washroom facilities. Individual lockers provided for all employees are located at the various departments, so that employees lose no time going to and from locker rooms.

All of the departments housed in special rooms are located along the north wall beyond the siding and could be readily extended if expansion of the other plant facilities required it. The enameling room, 40 ft. x 120 ft. and a degreasing room have equipment ventilated direct to the outside. Also located along the north side of the plant are testing department, compact experimental laboratory and blueprint room.

Semi-Conducting Rubber

SINCE THE advent of the use of electricity, rubber has been recognized as probably the most important pliable electric insulator known to industry. The fact that it is an insulator has created undesirable electrical conditions that scientists have endeavored to correct. One of those closely associated with these investigations is A. E. Juve of B. F. Goodrich Co., who in a recent statement set forth certain needs for electrical conducting rubber. The following paragraphs are abstracted from his statement:

"In many cases, particularly in industry, the discharge of a static accumulation in the presence of inflammable solvents or dust mixtures can be extremely hazardous. An article, when charged, may be discharged by grounding to the earth with a conductor or by contact with a body of opposite charge. In both cases the discharge, if the potential is sufficiently high, is accompanied by a spark. Its charge may also leak off slowly to the ground through air which is humid.

"In many rubber applications problems concerned with the generation and dissipation of static charges are important. Since normally compounded rubber is an excellent insulator, rubber products, which in service are subjected to frictional forces applied through or by another insulating material, will accumulate static charges.

"In some applications it is necessary for the successful performance of the article that the rubber composition provide a path for the discharge of static. The successful development of applications in this category is dependent upon the ability of the rubber technologist to provide compositions of various degrees of conductivity to bleed off static charges at a rate sufficiently high to prevent their accumulation to the danger point.

"By the addition of pigments developed especially for their conducting properties the resistance of both rubber and the synthetics can be greatly decreased. Starting with the more lightly loaded stocks, the synthetics are much better conductors than similarly loaded natural rubber stocks. The maximum conductivity is obtained with the maximum loading, which, of course, results in stocks which are very hard and inelastic. With stocks of this type, resistances in the range of 1-10 ohms per cu. cm. can be obtained."

Be Sure Interrupting Capacity Is Adequate

(Continued from Page 73)

480 v. Secondary System

To carry the plant protection to a logical conclusion, secondary circuit protection has also received a great deal of attention. A complete study of short circuit possibilities on secondary feeders was made, giving due consideration to transformer reactances, size of cable used, length of cable runs, and whether steel conduit or open runs were used. In a great many instances the calculations proved that circuit breakers which had been considered adequate in the past were unable to interrupt a short circuit safely. These inadequate switches are being rapidly replaced by modern, fast-operating low-voltage air circuit breakers installed in dead front switchgear structures. In many instances the new type air circuit breakers are being installed. These all have the ability to clear a severe short circuit without injury to themselves, and with perfect safety to the operators. The Plant Engineering Department has prepared a graph (Fig. 5) for the use of its engineers which shows the type of breaker to use to give adequate protection. In order to make the proper breaker selection, it is necessary to know the cable size being used, length of cable run from the transformer to breaker, and the size of transformer bank supplying the load.

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

From Shanty to Penthouse

IN the February issue of this section we presented a brief but glowing account of the success of George Hawkins' "Fused Man." This unusual collection of old fuses, it may be recalled, was described in the November issue and then, in January, as a result of publishing this description we issued a call for help—for the "missing link." Well, that started things. The missing link was soon found, several of them in fact, but more than that, the fused man became a celebrity almost over night. He became a figure of national importance and additional fuses were sent to him from all parts of the country to add to his stature. He was wanted at various exhibitions and calls came in to Mr. Hawkins from various organizations asking the fused man to visit them. "Old Man Fuse" was born in Mr. Hawkins' shanty as the latter describes it but since becoming a public figure he has moved to various places. He has lived on 5th Avenue and at the present time occupies a penthouse on top of the swanky London Terrace Apartments in New York City. So he rose from shanty to penthouse in four issues of Power Plant Engineering and that, we feel, is something to be proud of. A complete account of Old Man Fuse's more recent adventures will be presented in the April issue of this section.

A. W. K.

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A Section of Power Plant Engineering Devoted to PLANT OPERATION AND MAINTENANCE

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A SAFE METHOD OF TESTING SCAFFOLD PLANKS

By ELWOOD ROSSNAGEL
Safety Engineer
Consolidated Edison Co. of N. Y., Inc.

THERE is an urgent need for a means of subjecting scaffold planks to a load test which it may be assured will not weaken a good plank, yet which may be expected to indicate a defective plank. After several years of research and experiment a method has been developed which, while perhaps not infallible, has proven itself reliable during two years of actual practice by lumber inspectors passing on large quantities of newly purchased scaffold planks.

In many states the authorities require that all scaffolds be tested each time they are erected for use. This may be interpreted to mean that each scaffold plank shall be tested. It is usually specified that the scaffold, or plank, shall be placed a foot above the ground and that three times the normal working load be applied. Such wording of the law or code is rather ambiguous as it does not indicate whether the load is all to be applied at the middle of the span or if it is to be uniformly distributed along the length of the plank. A plank, or in fact any beam whether of wood or of steel, will carry a distributed load twice as great as the concentrated load.

AMONG the various odd and sundry jobs that fall to an engineer's lot is the erection of scaffolding for one purpose or another. It may be only a plank supported on two stepladders or it may be a high steel framework type of scaffold for painting the turbine room ceiling, in either case, it is necessary to use planks that will be safe. This warning may sound trite and unnecessary. It would seem only good common sense to pick planks that are safe to stand on.

No doubt it is common sense but a study of accident records proves that common sense is a virtue that seems to be indulged in only rarely. Furthermore, there is more than common sense involved in picking lumber for scaffolding. One cannot always tell whether a plank is good or bad merely by looking at it or feeling it. So it is desirable to subject them to some sort of test which will show whether they are strong enough for the purpose intended but which at the same time will not weaken the plank.

In this article, Mr. Rossnagel sets forth such tests. Those who read Mr. Rossnagel's articles in these pages on steel scaffolding, on wire rope and on lumber need no introduction to him. They know him as a man who knows what he is writing about and this case is no exception. In his letter to us he writes:

"In order to play fair with you, I might say that I had a highly technical article with all the mathematical calculations on testing scaffold planks of one size only published some time ago (last May, I believe) in the Engineering News-Record. The article which I am sending you now does not contain these rather involved calculations, but it does contain data on other size planks."

Then again, there is a marked difference in the strength of a plank under a steady load and under a suddenly applied load. Thus, the test called for by law is very indefinite. In fact, many men believe that a load test on a scaffold plank is not only useless but that it is actually hazardous, as there is a far greater possibility of injuring a good plank than of detecting a defective one. For this reason many safety engineers discourage the testing of scaffold planks except insofar as it is necessary to comply with the law.

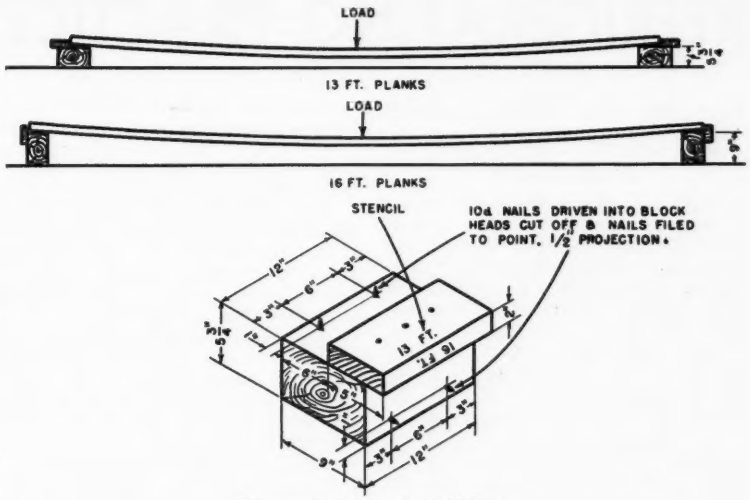
The safest method of insuring that only good scaffold planks are purchased is to have a competent lumber inspector or an engineer who is thoroughly familiar with the behavior of wood under stress make a thorough visual inspection of all faces and the ends of each plank, looking for oversize knots, splits, compression wood, compression failures, brashy wood, shakes, decay, etc. However, occasionally after having inspected a plank and having found no defect to which he can point his finger, the inspector may feel in his subconscious mind that there is a reasonable doubt as to its strength. To satisfy himself, he may then desire to apply a load test to the questionable plank. It is only in instances of this kind that a load test should be permitted, and even then it should be conducted only in a scientific manner according to definite rules if it is to be of any value in enhancing the workmen's safety.

Most scaffold planks are furnished in rather odd dimensions, 2″ x 9″ x 13′-0″ long, although they can be obtained in 2″ x 10″ x 16′-0″ and 2″ x 12″ x 16′-0″ sizes. Eastern spruce (consisting of Picea mariana, Picea rubra and Picea glauca) is the most common material as its weight is low compared to its strength.

It may be assumed that in normal use a scaffold plank will be called upon to support a maximum load of one man standing at the middle of its length. If a man should weigh 160 lb. then the test load as required by law may be taken as three times 160 lb. or 480 lb. concentrated at the middle of the span.

Take as an example a 2″ x 9″ x 13′-0″ eastern spruce plank of the poorest species (Picea glauca). The 480 lb. load concentrated at its midpoint will develop a bending stress of about 3920 lb. per sq. in. and a deflection of about 5¾″. Inasmuch as the stress and deflection are related, limiting the deflection to 5¾″ will automatically limit the stress to 3920 lb., regardless of whether the plank is deflected slowly or suddenly.

In other words, if the ends of the plank are supported on blocks 5¾″ high (which happens to be the size of a rough 6″ x 6″ timber) then 480 lb. static load will cause the plank to deflect and rest upon the floor. Increasing the load cannot increase the deflection nor the stress.



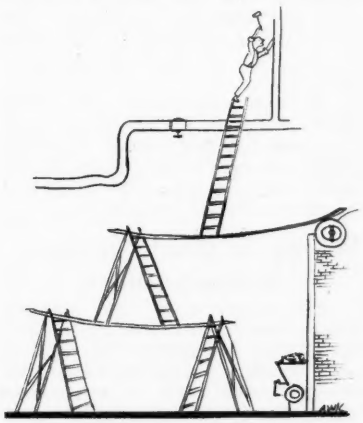
Fulcrums for Testing Scaffold Planks

TABLE I

Species of Spruce	Static Load Modulus of Rupture	Static Load Proportional Limit	Impact Load Proportional Limit	Modulus of Elasticity
Picea mariana	10,300 p.s.i.	5,800 p.s.i.	13,400 p.s.i.	1,530,000 p.s.i.
Picea rubra	10,200	6,800	11,900	1,520,000
Picea glauca	9,800	6,500	10,300	1,340,000

The proportional limit (elastic limit) of this species of spruce under a static load is about 6500 lb. per sq. in., or 1.66 times the developed stress. In other words the margin of safety (if that is the proper term to use) relative to the proportional limit is 1.66.

Now if this plank is deflected the same amount suddenly, the stress developed will be the same, but the proportional limit under impact loading is about 10,300 lb. per sq. in., thus giving a margin of safety relative to the proportional limit of about 2.63. In fact, it will be observed in Table I that the proportional limit under impact is somewhat higher than the static modulus of rupture. In other words, suddenly deflecting the plank 5¾″ is much less likely to damage the plank than deflecting it 5¾″ under a static or slowly applied load which is allowed to remain for some little time.



Every engineer has occasion to erect scaffolding

It is therefore considered more desirable to apply an impact load to the plank, assuming that the deflection is limited. Under no circumstances should an impact load be applied to a plank except when the maximum allowable deflection has been mathematically determined in advance. The recommended test should be accomplished by having one or two men stand close together at the middle of the plank and spring it up and down until it touches or nearly touches the floor, which of course should be a plane surface. If there is no cracking sound or other evidence of failure under the test, the plank should be turned over and the load applied to the other face. It is necessary to test both sides of the plank in order to insure against the presence of microscopic compression failures.

Wood is a rather peculiar material, which in this instance has characteristics which work very advantageously. Brashy (brittle) wood and wood containing compression failures are much weaker under impact than is good sound wood. On the other hand, as shown above, the margin of safety relative to the proportional limit is much greater under impact loading than under a static load.

In other words, the test described above is least likely to injure a good plank, yet it is most apt to crack or break a defective plank.

In order that spruce planks of the other sizes may be given this test the data in Table II will be of value. If the same blocks are to be used for successive tests it is suggested that they be made 5¾″ x 9″ by 12″ long so that they may be used for either the 13 ft. or the 16 ft. planks. To maintain a span 12″ shorter than the length of the plank, cleats should be attached to the block as shown in Fig. 1. Also in order to keep the planks from creeping off the blocks during the test it may be desirable to drive in some 10d nails, then cutting off their heads and filing the shanks to a point as shown. These points will embed themselves into the plank when it is placed on the blocks.

TABLE II

Size of Plank	Clear Span	Height of Blocks	Maximum Static Load
2″ x 9″ x 13′-0″	12′-0″	5¾″	350 lb.
2″ x 10″ x 16′-0″	15′-0″	9″	350 lb.
2″ x 12″ x 16′-0″	15′-0″	9″	500 lb.

It is believed that if this method of test is adhered to, there will be few, if any, defective planks which cannot readily be detected or identified by anyone regardless of his technical knowledge of testing. Such test may also be made in the field if there is reason to believe that a plank is of questionable strength.

REFRIGERATING PRACTICE

Keeping the Refrigerating Plant Up to Capacity

By A. G. Solomon*

WHEN discussing the actual capacity of a refrigerating plant most practical operating engineers think of the compressor only, and base all their figures on the number of compressors, their diameter and stroke and the number of revolutions per minute.

Of course, they consider whether the machine is single or double acting, and if double acting the loss in compressor area due to the piston rod.

The theoretical area is figured and then the actual displacement is arrived at by allowing a liberal volumetric efficiency. The exact volumetric efficiency is impossible to estimate, unless indicator cards are taken and correctly interpreted and the indicator is not in common use now as it was in the steam-engine and ammonia compressor days. So the volumetric efficiency is really guessed at and is taken anywhere from 85 to 95 per cent of the theoretical displacement. Just where, or how, the engineer finds out how many cubic inches or feet displacement represents a ton of refrigerating capacity, for his plant, is seldom stated, but it is a fact that most engineers have such a figure.

Analyzing the Problem

The actual capacity of any refrigerating plant is based on the number of heat units taken from the substance or space being cooled and delivered to the water or air that is used for the removal of heat at the condenser.

The compressor is that part of the system which moves the heat from the collecting place to the place of disposal.

The amount of heat taken up by the refrigerant varies greatly under different operating conditions. One important duty of the engineer is to see that every pound or cubic foot of refrigerant, handled by the compressor, is loaded as much as possible with heat units that represent useful work.

The total heat that is handled by the compressor can be divided into two parts, one being the heat taken from the substance or space being cooled, and the other part being that heat which enters from non-productive work.

It is obvious then that the engineer must exercise his ability to keep as many non-productive heat units as possible from entering the refrigerant.

The Condenser

We will consider the condenser as the starting point in the cycle. It is best to have the condenser located in a place where there is free circulation of air as this helps in heat removal. If the condenser is in a basement or surrounded by walls, the engineer must study the building construction and see if an air shaft cannot be arranged to carry the heat from above the condenser to some outside point.

The distribution of the condensing water must be such that every foot of surface delivers its full share of heat. Condensing surfaces must be clean, for any scale or other clinging substance acts as insulation.

The charge of refrigerant must be sufficient so as to allow the condensed vapor to travel slowly in the outlet part of the condenser so as to have the liquid leave as cool as the water temperature will allow.

Keep Heat Out of the Liquid

After leaving the condenser and before entering the evaporating coils, heat must not enter the liquid by way of the liquid receiver or any part of the liquid line which is exposed to a temperature higher than the temperature at which the liquid leaves the condenser. Insulate the receiver and liquid lines if necessary and the cost of the insulation will be returned in saving of power or fuel.

If the proper attention has been given the refrigerant in its passage through the condenser, liquid receiver and liquid line, the refrigerant will pass through the expansion valve and into the evaporator at the lowest temperature attainable unless provision has been made for liquid pre-cooling.

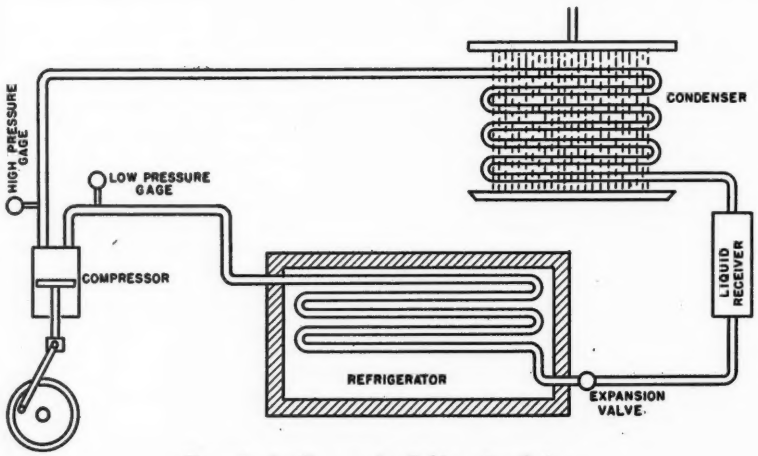
The pre-cooling of liquid by the evaporation of the refrigerant is, and always has been, a debatable question. The resultant vapor must be handled by the compressor so what is gained at one point is lost at another.

After the liquid passes into the evaporator it gives up the heat it contains and assumes the temperature of the saturated vapor and is then ready to take up its load of heat in the performance of useful work.

The temperature of the saturated vapor, in the evaporator, must be kept as high as possible and still allow a temperature difference sufficient to allow heat to flow from the substance or space being cooled.

The state of the vapor leaving the evaporator will depend on the amount of work being done as compared with the area of the evaporator surface. Each square foot of surface will allow for the transfer of a certain number of heat units. If the evaporating surface is large and easily able to handle the load we can have the vapor superheated 5 or more degrees at the evaporator outlet. Small area of surface and a heavy load will demand that the vapor leave the evaporator in a dry saturated state, so as to be sure that every foot of surface is doing its full share of work.

Next the vapor passes into the suction line and it must be protected from further heating by providing well insulated piping between the evaporator and the compressor.



Elements of a Compression Refrigerating System

In passing through the compressor suction valves and into the cylinder, the vapor becomes highly superheated but the engineer has very little control over this condition. All that he can do is to study the operation of the plant and decide for himself as to the best state of saturation or superheating to send the vapor to the compressor.

As some compressors are water cooled and some air cooled, the engineer must see that there is proper air circulation or the proper amount of jacket water to remove as much heat of compression as possible.

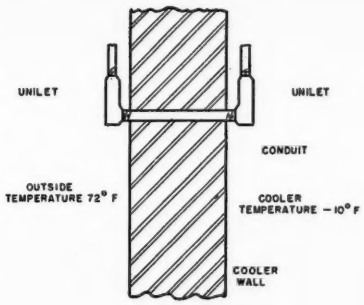
Wiring in Cold Storages

By George L. Radamaker

ANY METAL piping and especially electrical conduit is a good conductor of heat. This principle is the cause of much trouble in running electrical wiring through cooler walls in refrigeration plants, for light and power.

Ordinary rubber covered wire subjected to constant heating and cooling

*Deceased.



Wiring in cold storage

and deposits of alternating ice and water, as it does when run through conduit from warm outside temperature to cold cooling room temperatures, rapidly deteriorates and causes grounds and short circuits.

One method of preventing this is shown in the above drawing. A piece of conduit is run through the cooler wall then unilets are attached at each end, and sufficient wire pulled through to have an excess of about 12 in. on each side. Then the conduit is filled with hot tar and allowed to solidify.

This will prevent rapid heating and cooling of the insulated wire and constant deposits of water and ice, thus contributing to a longer life of the electrical wiring installation.

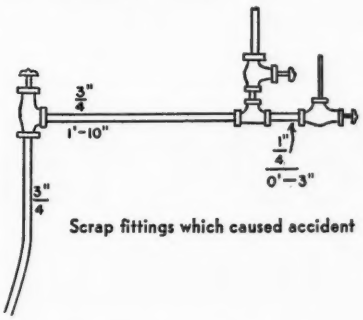
Ammonia Trapped 13 Years

In 1925 The Southwestern Gas and Electric Company erected a 340-can, high pressure ice plant. As soon as the plant was under full production, a small 10-ton plant in an adjoining room was taken out of service. However, this plant was left intact except for the ammonia compressor which was disconnected.

The sketch shown here is of the three valves which were attached to a piece of ¾-in. pipe, the total overall length of which did not exceed 25 in. In addition to the internal volume of this pipe, there was a ¾ in. tee together with ¼ by 3 in. nipple and parts of the three valves below the seats. The valves and pipe were part of the liquid ammonia line feeding the evaporating coils in the abandoned plant.

In 1935 the old plant was dismantled and the evaporating coils, then badly corroded, were removed from the tank, the tank cut into sections, and all of the equipment sold as junk. The three valves shown in the sketch, together with short sections of pipe, found their way into the plant scrap pile.

In 1938 Mr. Connor, the chief engineer, had occasion to use a ¾ in. valve, and went to the scrap pile to disconnect the valve from the short section of pipe. Each of the three valves were tightly closed. Mr. Connor started to unscrew one of the bonnets of these valves and upon loosening the bonnet he was sprayed with a combination of oil and ammonia, some of which burned his face and one eyeball. Mr. Connor was treated by a competent physician and after several months was pronounced completely recovered. For a time, however, it seemed that the sight of one eye would be permanently injured.



Scrap fittings which caused accident

This accident reported by L. P. Reiss is brought to the attention of the industry to show that, even though a piece of pipe or any other part of ammonia equipment in which ammonia may be trapped has been out of service many months, it should always be handled carefully when opening. In this case, 13 years had elapsed since this part of the equipment was in actual service, and three years had passed from the time this particular pipe and these valves were taken from the system and thrown in the junk heap.

Finding Cracks in Metals

By W. E. Warner

Cracks can be found in small metal posts by first cleaning them. Immerse them in a pot of warm thin oil and leave them long enough to attain its temperature. Then withdraw them and dry with a cloth. This should be followed by painting with thin whitewash. When this is dry a few taps from a hide or wooden mallet will cause oil to ooze from any cracks showing their position and extent.

For machined surfaces which cannot be moved, first clean them and then paint with gasoline to which a little red lead has been added. The gasoline will soon dry, the red lead coloring should be wiped off with a dry cloth. Then examine the surface through a magnifying glass; if any crack exists a red streak will be seen in the metal where the red lead has worked in the crack and has not been wiped off.

"You were saying the bonnet joints on the two throttle valves were of the tongue-and-groove type, made with gas-filled hollow ring gaskets,—do go on!"

Our Hero's Pump Problem in the January Issue turned out to be not a pump problem after all. It was an electrical problem—one which actually happened in fact, and one which gave a great deal of trouble before it was solved. All our hero needed to cure his trouble was a wrench and an understanding of synchronous motors.

How Would You Do It?

PROBLEM 14
PUMP WILL NOT START

THE impending assault on Britain, increasing tension in the Balkans, the situation in the Far East, controversy over the lease-lend bill, aid to Britain, our own defense program, all these things, serious as they are, they all fade into insignificance when compared to the problem confronting our august Board of Judges in deciding on the prize winning solutions to Problem No. 14. Assembled in solemn conclave for over a month while the solutions poured in from all parts of the planet, indeed there was some suspicion at one time that one of the answers was sent in from Mars but it finally proved to be only a (dis)solution from Pulverizer Pete, the poor old guys were almost at their wits end. Many times they had to send out for beer and pretzels to revive their decaying faculties.

In the end, they did manage to arrive at a decision but long before that they decided that this Hero guy was nuts. This was a unanimous decision and its announcement was accompanied by wild acclamation. They figured that any galoot that did not know any better than to mix amortisseur windings with pumps and who could say so little in so many words was a prize idiot. In coming to these conclusions, the judges were not alone; some of the contestants were also of that opinion. Paul Armstrong of Los Angeles wrote: "Sometimes I think your hero is full of practical jokes, or at least he tries to see how ambiguous he can be in stating a question. . . . He specifically states that he has a centrifugal pump and that it is a service pump. . . . Therefore he is not correct when he says two things. 1. He is not correct when he says he can operate the pump empty, or at least he implies that he can operate the pump empty. This is contrary to all manufacturers' rules and regulations. 2. Again, he is not correct if he was able to run his pump empty that, he would not cause the water to enter the pump once it is up to speed. This is a gross misstatement. Almost any priming device known will prime the pump providing it has been properly installed." Mr. Armstrong writes with much feeling and winds up his letter by saying, "These people that don't know pumps shouldn't write about them because too many practical engineers have had practical experience in operating them."

Be that as it may. To say the least, our Judges took it to heart, but the fact remained that the trouble with our Hero's pump installation was not with the pump, but with the motor. It was in the amortisseur winding.

Mr. Armstrong points out in his letter that the first function of an engineer is to be able to state his problem before he starts to solve it. Truer words were never spoken, but the quality which Mr. Armstrong demands is rarely found. From our own experience, we find that the engineer that can state his problem fully and completely is an exception.

We will be the first to admit that much more information could have been presented in stating Problem No. 14, but, it will be noted that we said "If you had this installation and these facts were brought to your attention where would you start looking for trouble and what do you think might be wrong?" What our hero wanted was a program for investigating the cause of his trouble.

It is for this reason that our judges awarded the first prize to Mr. Mailhos whose letter is presented below. As will be noted, Mr. Mailhos gives very detailed instructions for finding the trouble and his approach is logical. He begins with a consideration of the motor and that, after all, is the logical place to start. The motor drives the pump and so the first thing to look for in a case of this kind is to see if the driving element is in operating order.

As it happened, and this problem was based on an actual occurrence, the trouble was in the amortisseur winding of the motor. Some of the bars were loose—they did not make firm connection with the end rings. As a consequence, the resistance was high and the starting torque low. Tightening the bolts holding the bars to the end rings cured the trouble at once and the motor came up to speed easily under load.

Simple? Yes, of course, but so many answers failed even to consider it. It is the first thing Mr. Mailhos looks for and if it had been his motor he would have found the trouble at once. While, Mr. Lubeley who was awarded second prize and Mr. Chaney who won third prize also suggested checking the amortisseur windings, Mr. Mailhos was awarded first prize because of his unusually comprehensive and logical plan of procedure.

First Prize Award

H. H. Mailhos
Electrical Engineer
Brunswick Pulp and Paper Co.
Brunswick, Georgia

The successful starting of synchronous motors, under load, depends largely on proper control equipment. Your problem does not state the type of control you are using for starting this motor; therefore it makes it hard to diagnose the probable cause of trouble you are having in getting the motor to synchronize.

I will first discuss the possible faults of the motor which may prevent it from starting under load. First, check the amortisseur winding for broken bars and high resistance end connections, making sure that all joints are clean and tight. If the motor has the pedestal bearings, check the air gap between the rotor and stator, being sure it is equal all the way round. Next check the field coils for open circuit and short circuited turns. In checking for open circuit you can use a "megger" or apply voltage to the field and if you do not get an ampere reading you have an opening in the field circuit at some point.

In checking for short circuited turns, apply 60 or 70 v. to the field of the motor and take voltmeter reading across each

field coil. These readings should be the same and any coil showing differently has some internal trouble.

A check of the field coil connections should be made to determine if you have an alternate north and south pole throughout the field windings. This can be accomplished by the use of a compass.

We will now discuss conditions outside the motor that might prevent it from starting. Check the supply voltage to see that proper voltage is being applied to the motor and if the motor is wound for dual voltages, make sure the proper connections are made at the motor.

Next check the voltage drop while the motor is being started. If this drop is found to be excessive, it should be corrected at once. The torque of a synchronous motor varies directly with the square of the applied voltage, hence any reduction in voltage reduces the torque of the motor. In case the motor is of the reduced voltage starting type, employing an auto-transformer for starting, this condition can be improved by setting up the taps on the auto-transformer, thereby giving a higher starting voltage. If the motor is full voltage, or across the line, starting type the lines supplying voltage to the motor will have to be enlarged to prevent this drop.

The frequency of the system must also be maintained. Any variation in frequency will also vary the torque of the motor even though the voltage be maintained.

The application of field to the motor also plays an important part. A synchronous motor will synchronize the greatest load when voltage is applied to its field at the critical speed (a speed which differs according to motor characteristics and the application, but is always within a few per cent of synchronous speed). For example, if the critical speed of an installation is 95 per cent of its synchronous speed, but field is applied at 94 per cent (1 per cent less) pull-in torque may be reduced by as much as one-third. If field is applied to the motor automatically, by the use of definite time relay, I would lengthen the time of applying the field until the motor has reached its maximum speed. If field is applied by hand the time will have to be checked against the speed of the motor, using a stop watch and tachometer, until proper time and speed for field application is found.

Check the current transformers, making sure they are of proper ampere capacity for the motor. If they are too small the relation of current to voltage will be upset and the motor will not pull in step, due to power factor relay removing same from the line.

Not knowing the type of control used in starting this motor, it is hard to diagnose the exact trouble with the installation. Assuming the motor has the necessary torque and the control is the automatic type, I suggest the wiring be checked throughout, especially the wiring to the power-factor relay. By observing the power-factor relay when the motor is started under load, it can be determined whether it is functioning right or not. If you have faulty power factor relay operation and the secondary control transformer power is taken from primary leads entering the motor controller, the fault may be corrected by reversing incoming primary lines 2 and 3 ahead of the transformer and, of course, reversing the motor leads to maintain proper rotation of the motor.

Should no trouble be found in either the motor or control and still the motor will not start its load and assuming the pump to be in perfect condition mechanically, I would say the motor does not have the necessary torque for the load it is required to start. If it can not be exchanged for proper type, the only recourse would be to install a magnetic or hydraulic clutch between the motor and pump. The motor could then be brought up to speed and the pump connected to same through the clutch medium.

Second Prize Award

A. J. Lubeley
Chief Engineer
Anheuser Busch, Inc.
Old Bridge, N. J.

From the information supplied by "our hero" it may be assumed that the motor in question is a medium sized high speed synchronous motor with 125 v. excitation and no separate field discharge circuit. The starting procedure recommended by the manufacturer will probably be as follows: 1. Open the field switch. 2. Close the starting compensator. 3. Close the field switch. 4. Close the running switch.

Since the motor will start readily when the pump is empty, it would appear that the starting torque is only sufficient to accelerate the machine at absolutely no load, but is not strong enough to overcome the additional friction imposed by the priming of the pump. This being a rather unusual occurrence, abnormal conditions must be looked for. First of all, the external wiring should be gone over carefully to make sure that none of the wires has been damaged during the installation, and that there are no loose or defective connections. Next, "our hero" should inspect the squirrel cage winding of the motor. If any of the connections between the squirrel cage bars and the short circuiting rings are faulty or broken, this might greatly weaken the starting torque.

With nothing amiss either in the mechanical condition of the motor or in the electrical hookup, the difficulty may be due to some peculiarity of this particular

PROBLEM 15.
IMPROVING THE WATER SUPPLY

Considering Our Hero's propensity for getting into jams it would not seem possible that he could be confronted with a problem of some 18 years standing, yet, such is the case. This particular problem has continued through 18 years of operation and only recently has any thought been given toward future correction. Our hero is the "last word" and final authority as to what should be done, so before any money is spent, he wants to be sure that his advice is correct.

The water supply to the hospital where he is engineer is wretched. For a mile, the pipe to the town main is 2½ in. not too badly scaled or corroded. The demand exceeds the supply at all times when the valves to the laundry washer are open. At such times the pressure drops so that no water at all is available on the third floor where the Operating and Delivery rooms are located. This constitutes an awful nuisance when doctors are scrubbing up and the laundry man has to partially close his valves many times a day with consequent hindrance and delay.

Drawing from this 2½ in. supply there may be at the same time the two 1½ in. laundry valves, two or more flushometers with 1 in. feed, and at least six faucets with ¾ in. feed. It is plain to see where the pressure goes.

Our hero maintains that no matter how much the size of the supply pipe to the town main is increased—at tremendous cost for a small institution—the problem would still continue owing to the layout inside the building where the 2½ in. feed is immediately cut down to 2 in. branches, diminishing in size with the run.

If a new supply main or changing the piping layout is out of the question, is there any other way this problem can be solved? Our hero has several things in mind but he would like the benefit of the experience of others. Both hot and cold water is necessary.

Write out your opinion of this problem in a letter of not over 1000 words and send it in to the Contest Editor by March 25. A first prize of $15 will be awarded for the best letter, a second prize of $10 and a third prize of $5. Entries should be addressed to the Contest Editor, Technical Publishing Co., 53 West Jackson, Blvd., Chicago, Ill.

installation. Considering that the starting torque of synchronous motors is usually only sufficient for no-load acceleration of a machine under average conditions, an abnormal frictional load in some specific case may prevent synchronization. Special features in the design of the impeller or pump casing, abnormalities in impeller and guide ring clearances, accuracy of alinement, design of the bearings and the type of lubricant used in them—all of these factors affect the total frictional load. If such "local conditions" are of such a nature that nothing can be done about them, measures may sometimes be taken to increase the pull-in torque of the motor.

By reversing operations No. 3 and 4 of the starting procedure—that is, by closing the running switch ahead of the field switch—full line pressure is applied to the stator which may strengthen the rotating magnetic field sufficiently to pull the rotor into step. If this method fails, provision should be installed for short circuiting the field winding of the rotor when the latter has reached nearly its maximum speed during the starting cycle. Short circuiting the field at this point decreases the total rotor resistance with the result that the rotor will attain a slightly higher speed, and thus fall more easily into synchronism. This procedure, however, requires careful timing or it may defeat its own end. If the short circuiting switch is closed too soon, the starting torque will be reduced and acceleration may stop at half the synchronous speed. To understand this apparent paradox we must remember that the resistance in the rotor circuit has a dual effect: 1. It increases the starting torque. 2. It causes the rotor to lag behind synchronous speed.

Therefore the removal of resistance during the early part of the starting cycle (by shortening the field) would weaken the torque. However, toward the end of the cycle, when a powerful torque is no longer needed, it is important for the rotor to approach synchronism as nearly as possible. By reducing the resistance of the rotor at that time, we can "help the rotor along," as it were, without unduly decreasing the torque.

This condition, incidentally, suggests another possible answer to "our hero's" problem. If his motor is provided with a field discharge circuit and an automatic short circuiting switch (and a field discharge resistance) the arrangement may be such that the short circuiting device is in the closed position when the motor is standing still. In that case, I should suggest removing the discharge resistance and changing the control of the short circuiting device in accordance with the requirements outlined above. The short circuiting switch, however, should remain interlocked with the main field switch in such a way that the former will be opened automatically when the field switch is closed. In as much as changes of this kind may involve problems of over-current and over-voltage protection of the field windings, it is advisable to consult the manufacturer of the motor before deviating in any way from the wiring diagram furnished with the machine.

Third Prize Award

L. P. Chaney
Houston, Texas

Since the synchronous motor fails to pull in step with the pump primed, the pump must require more torque at synchronous speed than specifications call for or the motor must have less than 100 per cent pull-in torque under existing starting conditions. Assuming that the pump torque requirements are excessive, check first to see that the pump is not overloaded due to the discharge pressure being too low. If this is true, the condition can be corrected by throttling the discharge or shutting it off altogether during the starting period.

If power requirements were calculated on the basis of an induction motor drive, an error of about 4 per cent in speed occurred. Since the power required by a centrifugal pump is proportional to the cube of the speed increasing the speed 4 per cent raises the power requirements 12.48 per cent. If this error in calculations occurred, it can be corrected by machining the impeller or impellers to a smaller diameter. Before taking this step, the problem should be referred to the manufacturer. If cut and try methods are used, the diameter should not be reduced more than about 1 per cent between trials. The total reduction required will probably not exceed 4 per cent.

Assuming that the pump requires no more power at synchronous speed than the motor rating, the lack of pull in torque may be due to low voltage at the motor terminals. It may also be due to the field being applied too early. If the trouble is within the motor, the amortisseur winding must be poorly installed or of faulty design. Before assuming that the motor is at fault, consider that the starting and pull in torque of a synchronous motor is proportional to the square of the applied voltage. If the starting voltage is reduced to 90 per cent of rating, the torque will be reduced to 81 per cent of that obtainable with rated voltage.

If the amortisseur winding requires attention, silver solder should be applied to all joints likely to be of too high resistance. This applies to bolted as well as riveted joints. If design is at fault, more bars should be installed or a new winding provided. However, this should be referred to the manufacturer. When increased starting torque is built into a synchronous motor, the starting current requirements are also raised.

While it is generally easier to remove the air from a centrifugal pump while it is at rest, it is possible to provide reliable means for priming the pump while it is running. If the air vent at the top of the pump casing is of ample size and the suction is provided with a good foot valve, the introduction of a generous stream of water from another pump or a storage reservoir into the suction line should readily force the air out of the pump. Some irrigation pumps are intentionally equipped with synchronous motors of such low pull in torque that the pumps must be started empty. No foot valves are used for such pumps. Vacuum pmps of a type not damaged by slugs of water are used to remove air from the pumps. The discharge line must be immersed or provided with a check valve. At one such installation, flood water rose high enough to keep an idle pump primed. An air compressor was used to force water from the pump while it was being started.

The Problem Was Based on Fact

As already mentioned this problem was based on an actual case encountered in practice and as correctly interpreted by the letters presented above was purely electrical in nature. The pump was OK. After several trouble shooters had unsuccessfully tried their hand at it, one of them began to check the motor carefully and upon measuring the resistance of the connections in the damper winding found immediate evidence of loose connections. Tightening the bolts holding the bars to the end rings, the trouble disappeared at once.

Many other of the answers sent in were on the right track. Leslie Ewen of Danville, Ill., was very close when he said—"the motor should start slowly and *if the damper winding has been properly designed* it should come up to nearly maximum speed in less than 1½ min."

R. A. Julsurd on Harmon-on-Hudson also probably suspected the nature of the trouble in his most excellent analysis of synchronous motor action, though he did not say it in so many words. So, also, did Leslie Bradley of Bismarck, N. D., when, in his letter he says, "The first thing he should do is to check the wiring of the motor, especially the damper winding as there might have been a mistake in some of the connections." This points directly at the trouble and the fact that Mr. Bradley's letter was not included in the awards is no reflection upon his power of analysis. The awards, of course, are made on the basis of the best overall letter. Like many others, after considering the electrical phase of the problem Mr. Bradley makes suggestions overcoming the trouble by altering the pump connections. Among other things he suggests "running an auxiliary pipe line to the inlet of the pump; this line to be supplied with water under enough pressure so as to prime the pump after it had been started without water in it." Another suggestion he proposes is to "buy a clutch that would be suitable for his needs."

Quoting from Mr. Julsurd's letter, he points out "A synchronous motor is similar in construction to an alternating current generator. Its stator winding is connected to the supply line, as in the case of an induction motor, and direct current is supplied to its rotating field coils, through brushes and collector rings from a small

direct current exciter which is usually coupled to the synchronous motor shaft. An auxiliary winding called an amortisseur or damper winding is provided to insure stable operation of the motor. This winding is similar to that of the rotor of a squirrel cage induction motor and is placed in slots in the rotating field." (Mr. Julsurd comes close here but he does not discuss what might be wrong with the damper winding.) In discussing the starting torque, he indicates "higher starting torque may be obtained in this type of motor by placing resistances in series with the stator. These are inserted in each phase and are gradually cut out as the motor approaches synchronous speed."

In other words, Mr. Julsurd shows excellent understanding of the operation of the synchronous motor but he fails to mention specifically the nature of the trouble in this case.

Like Mr. Bradley, he ends his letter by suggesting the installation of a built-in clutch.

Such suggestions of installing clutches for starting the pump gradually after the motor is brought up to speed without load, or employing various priming connections to accomplish the same purpose, however, effective they might be, do not constitute a really satisfactory solution to a problem such as this. They are makeshifts devised purely to overcome a condition that should not exist in the first place. It is much the same as taking aspirin to get rid of a headache that is due to a chronic stomach disorder. The more logical procedure in this case would be to take steps to remove the cause of the headache.

Headache No. 1

And speaking of headaches reminds me of that old screwball Pulverizer Pete. Since he started running his own prize contest we had hoped that we would be rid of him in these contests, but no such luck. True enough his answer came in so late that we would have rejected it anyway, but we had to put up with it and that started a row among the judges. Judge for yourself.

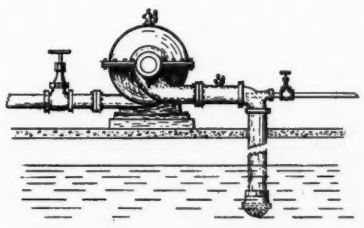


Fig. 1

"Dear Contest Editor," writes P. Pete. "This afternoon I is lookin' over P. P. E. and I reads where you run a prize contest about your hero and a synchronous motor. So I looks at my favorite synchronous motor, which I likes best when it is 5:30 Friday, and sees where I got time to give you the benefit of my extra special knowledge about synchronous motors.

"Then I reads the problem again. Well for the love of somethin'; suppose I says to you: 'I just buys a car, it won't climb Pike's Peak like the guy what sells it says it will. How come!' You says, 'Tell me more. How does it act? What kind of gas is in it, if any? How many people in it? etc., etc.'

"Now, I can't ask you any questions, but maybe you gets the point which is, I think your problem is cockeyed. Anyhow, I answers it.

"My first guess is that the manufacturer is wrong about what his pride and joy can do. But I don't think you likes that answer, so seein's I ain't writin' these column inches for peanuts I gives you some more.

"Guess number 2 is that your hero does not line up the pump and motor so hot and that the friction load is so big when the pump is full the squirrels in the squirrel cage cannot run fast enough to bring the speed up to where it pulls in [The dope thinks there are squirrels in a motor! Ed.] I don't like that answer, so I keeps goin'. Personally if I really believed the thing would run if it ever got up to synchronous speed I would fix up a tank of water on the roof for its supply head and start it empty. [More aspirin. Ed.]

"By this time maybe you and me gets the same brain wave—which is maybe I should stop guessing and analyze the problem. Which I now does.

"It seems to me this hero guy never goes in for split hairs so I guess he don't go in for split phase starting neither. So I assumes that this here motor is a polyphase gadget if it is going to start."

* * * *

It is no use quoting any further from Pete's letter because even though he thinks he is analyzing he is still guessing. He rings in a lot of things, power factor, over excitation, the regulation of the power supply, but he never once gets near the right solution. So we don't give him a prize. The judges' decision on this also was unanimous.

With Regard to the Pump

Among the many answers suggesting changes in the pump connections, Carl Tinker's method is typical. Assuming that our hero is on the spot unless he can get the pump going at once he suggests the arrangement shown in Fig. 1. As he points out by draining the casing before starting and thereby relieving the motor of any active load, the motor should pull into step without hesitation. It is then only necessary to prime the pump. Figure 1 shows a sure fire method which Mr. Tinker says he has used successfully on a number of installations. "Just connect an auxiliary water supply having some pressure to the suction line as shown, allowing the nipple to project inside the tee in such a manner as to form a jet. There is likely to be little suction created by the jet, but it insures that after the pump is started the impeller is sealed sufficiently to draw water from the well or tank up to the pump. If the suction lift is rather high it sometimes may be necessary to partly close the discharge valve in order to build up a pressure within the pump casing. A foot valve should, of course, always be installed. Then the cocks on the suction pipe and pump can be opened to blow the air out and the pump will fill with water."

Effective as these methods are, as pointed out above they should not be necessary. A properly installed pump should not require such auxiliary arrangements.

Charles J. McClinch's answer deserves mention because he brings up a very interesting point. He says, "Our hero chose the wrong method to correct his troubles. Due to the fact that a house pump operates intermittently under control of a pressure switch or a float switch a synchronous motor is not a proper motor for such service. Furthermore, in order to correct the power factor of the system a synchronous motor should be in constant operation."

This is an excellent observation and discloses an understanding of synchronous motor application that few other letters brought out. Of course, it could be assumed that in this particular case enough service water is needed to maintain the pump in continuous operation but Mr. McClinch does well to point this fact out. In closing his letter Mr. McClinch says, "If our hero had chosen an induction motor with its higher starting torque and its simplicity of starting and also installed capacitors to correct his power factor, his troubles would have been solved."

Among other letters which pointed to the correct trouble were A. C. Pasini's of Detroit, Michigan, and Carl Egerter's of New York City. Mr. Pasini, in particular, is quite definite when he says in starting his letter, "An inspection of the pole phase winding connections and of the two end rings of the rotor might reveal loose connections. Loose connections affect the starting torque characteristics considerably. If the connections are found to be tight, I would simply lay the fault to a bad design condition of the pump and motor installation.

Mr. Egerter was not quite so explicit but his discussion of the nature of the damper winding is to his credit.

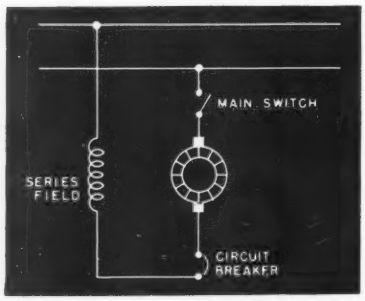
On the whole, those that considered our hero's problem fundamentally as one of an electrical nature showed good analytical perception. It is true, in a motor driven pump installation of this kind, the trouble might have existed in the pump but even so, the proper method of approaching the problem was in considering the motor first.

Questions And Answers

101

Is This Dangerous?

Q. One of the old direct current generators in our plant is connected as shown in the accompanying diagram. It is a 250 v., 75 kw. machine. Is there any danger in connecting the machine as



shown? It is not a standard connection, but it has never given us any trouble. Several people, however, have told me that it is dangerous to operate a machine this way. I would like to know if there is any harm in it?

Athol, Mass. H. GOULD

102

Refrigeration Effects

Q. Will you please explain what is meant by the following statement, "More total refrigeration effect is accomplished by a compressor operating at high suction pressure with a given speed," also, "More refrigeration effect is accomplished at higher speeds with a given suction pressure."

Baltimore, Md. W. T. C.

A. Refrigeration effect as measured in B.t.u. per hour is directly proportional to the weight of ammonia or refrigerant passing through the system. The volume of refrigerant handled by the compressor is directly proportional to the compressor piston displacement but the weight of refrigerant handled depend upon both the displacement and the specific weight of the refrigerant at suction pressure.

With the compressor operating at constant speed, the displacement is, of course, fixed, but if the suction pressure is raised, a greater weight of refrigerant is handled each stroke due to the higher specific volume. For instance at 15 lb. ga. suction pressure the specific weight of ammonia is 0.0568 lb. per cu. ft. and at 20 lb. ga. it is 0.744 lb. per cu. ft., therefore, theoretically an increase of from 15 to 20 lb. in the suction pressure would increase the weight of ammonia handled some 30 per cent.

In addition, there is a slight increase in the total heat for the pressure given above. This amounts to about 4 B.t.u. a lb. or roughly, 1 per cent of the total refrigeration effect.

With the suction pressure held constant, the weight of refrigerant handled is directly proportional to the compressor displacement which is in turn a direct function of the compressor speed. Increasing the speed approximately 30 per cent would give about the same increased refrigeration effect as increasing the suction pressure from 15 to 20 lb. while holding the compressor speed constant.

A. 85

More About H. F.'s Pump Constant

A. In your December issue, under the heading "PUMP CONSTANT", H. F. asks for a better way of estimating the daily consumption of coal in his boilers.

There certainly should be a better way, for that described looks very much like walking all around the block to call upon your next door neighbor.

In dealing with this problem, there appear to be several things which may be taken for granted.

1—There is no difficulty in figuring the monthly coal consumption.

2—The last boiler test was made five years ago, and then, quite possibly, no account was taken of the amount of blowdown, and other losses occurring in day in, and day out, operation; moreover, there is no assurance that either the condition of the boilers, or their operation, is the same today; in other words, there is entirely too much guessing about this, to make it a reliable factor in figuring coal consumption.

3—The method of using the pump as a measuring instrument for coal consumption, is unnecessarily involved.

Obviously, the most reliable way would be to measure the coal used either by weight, or by volume. H. F. does not say whether the boilers are hand fired, or mechanically fired, but it should not be difficult to rig up a truck of definite capacity which could be used for bringing and measuring the coal to the boilers, for a day or so, now and then, even if it is not convenient to use it continuously.

Suppose we did this, for a day or two, at the same time recording the number of strokes made by the feed pump, during the time that amount of coal was burned. A definite number of strokes would represent a definite amount of water, which, over a period of time may be assumed to represent a definite amount of coal, and it would not be necessary to know the amount of water, but only the number of strokes.

Having got a calibration of our pump, on this basis, we can check up at the end of each month, against the amount of coal actually consumed, and correct our calibration, if necessary.

By doing this every month, we should soon get a very reliable record of the number of pump strokes representing the consumption of a certain amount of coal, under average operating conditions.

In addition to the above, any considerable variation from normal conditions would be indicated at the end of each month. In case of any doubt, we could resort to our measuring truck, and check the amount of coal used in a day, against the number of pump strokes.

As we are presumably using a positive displacement pump, and of course, there should be auxiliary equipment for boiler feeding, it should not be difficult to take the pump out of service and actually measure the amount of water pumped per stroke, without any guessing as to slippage, etc.

If we do this, and make proper allowance for blowdown, we should be able to get a quite reliable indication of the daily performance of our boilers, as we would know within a fair degree of accuracy, the amount of steam produced.

We must remember, however, that if we also use the pump strokes to measure the coal consumption, we cannot ascertain the boiler efficiency, as indirectly, for the purpose of measuring coal, we have assumed that to be constant, but if we measure the coal independently, we can at any time ascertain, with at least a fair degree of accuracy, the combined boiler efficiency, and in any event, if we know definitely the amount of coal used per month, we shall have a very useful record of our average monthly operation.

We should then have something worth talking about, as coal consumption, unrelated to steam production, does not mean very much.

JAMES O. G. GIBBONS

Bloomfield, N. J.

A. 85

A. The method used by H. F. to figure the daily coal consumption is entirely unsatisfactory. Even if assuming that the water used by the boilers as determined from the pump strokes is correct, it would be very poor engineering to divide this by 9.6 and call the result the coal consumption. An evaporation of 9.6 is not likely to be obtained in a plant that does not seem to have any other instrument besides a pump counter, although it might have been obtained at some test during which time the firing must have been supervised by a technical

man. I doubt very much if the evaporation is over 7 lb. of steam per lb. of coal.

Before going into the means of determining the coal consumption, I will say a few words as to H. F.'s method of measuring the water. He says that the pump slippage is 27 per cent, but this does not check with the other data given. The dimension of the water cylinders being 5.5 x 10, this figures about 8.5 lb. of water per stroke. He speaks of the counter readings as "revolutions" but this being a duplex pump each counter reading means 4 strokes for the two cylinders, so that each counter reading should account for 34 lb. But since the constant used is 16.5 the slippage is about 50 per cent.

I, too, have used a pump counter to measure the boiler feed but have found it very unreliable. Immediately after packing, the slippage would be small but would increase to 50 per cent or more as the packing wore out. Not only does the slippage vary from month to month but varies with the load. The load on the night shift or Sunday being light, the per cent slippage is greater. Another cause of error is a short stroke. If the pump counter can be checked occasionally, its use will be of some value.

As to the method to be used to determine the coal consumption, this will depend on the firing equipment. I have used revolution counters on both chain grate and underfeed stokers and have obtained satisfactory results. The best way to determine the multiplier is from a measured amount of coal which should also be checked against the monthly tonnage purchased. If the boilers are hand fired or for some reason the coal cannot be measured mechanically, even if stoker fired, it would be all right to estimate the daily coal from the water evaporated but the ratio of coal to water should be determined with care and not use some evaporation that might have been obtained in some test several years back.

Briefly my advice to H. F. is this: Check the pump counter against something else occasionally. If the coal cannot be measured mechanically by counters on the stokers, determine the monthly evaporation rate by dividing the monthly water by the monthly coal tonnage purchased and use this ratio to figure the daily coal from the daily feed water.

Oak Park, Ill. N. T. Pef

103

Water Density and Temperature

Q. In your book "Boiler Plant Operation" on page 233 of the 1935 edition, you present a statement as follows: "Density is the measure of the amount of impurities in water."

Now, according to my limited knowledge of the subject, water has its greatest density at a temperature of 39.4 deg. F. If that be so, and the water is pure and has no impurities, it follows from the statement in your book, that the great density of water at that temperature must be due to impurities. This does not seem logical.

Also, let us assume water to be at a high temperature. It has expanded, hence is less dense than it was at a lower temperature. What became of the impurities?

This letter is not intended as a criticism of the statement in the book. I am merely seeking knowledge. Can you explain this more clearly?

Raymond A. Moroney

Chicago, Ill.

A. Both statements regarding density referred to in your letter are correct. One, however, refers to density with respect to composition and the other with respect to temperature. Pure water has its greatest density at 4 deg. C. (39.4 deg. F.). According to this definition, if such pure water is heated to a temperature of, say, 100 deg. F., its density will naturally be less than it is at 39.4 deg.

Suppose, however, that at 100 deg. certain impurities are added to this water. These impurities will then increase the density of the water with the result that the water at 100 deg. may have a density considerably higher than that of pure water at its point of greatest density—that is 39.4 deg. F.

From this it should be evident that the two statements mentioned in your letter have no relation to each other. Each one describes the density of the water with respect to certain conditions. Given a water with a certain amount of impurities in it, at a certain temperature, this water will be less dense if the temperature is raised to a higher value.

Of course the addition of impurities to water changes its freezing point and, therefore, also the point of maximum density with respect to temperature. In other words, the 39.4 deg. referred to as the maximum density of water holds only in the case of pure water. As you know, if salt is added to water, the freezing point is lowered and, of course, also its point of maximum density.

When water is heated, it is true, as you indicate in your letter, that water expands and is less dense than it is at a lower temperature. It contains the same amount of impurities, however.

104

DETERMINING POWER COSTS

A certain 1500 kw. turbine has a guaranteed water rate of 13 lb. per kw-hr. when operating under the following conditions:

Steam pressure at the throttle, 250 lb. gage.

Superheat, 150 deg. F.

Vacuum, 27.5 in.

Can the Rankin Cycle Efficiency of this machine be determined from the Mollier Diagram? Can this be done without making any assumption? can the water rate, when operating under the primary steam conditions as given above, with the same superheat, be determined, when operating at 26 in. vacuum?

I would like very much to have a solution to this problem as I am confronted with the determination of power costs with this unit operating at a location where the conditions are such that the vacuum in the summer months cannot exceed approximately 26 in. I would not want you to say that the correction will be such and such for the lower vacuum but would appreciate very much an analytical solution. Perhaps some of the readers can help me out in this matter.

F. C. D.

105

Fractional Exponents

Q. On page 187 of the 4th edition of the Power Plant Engineering Question and Answers Book, there is a formula for finding the size steam pipe to carry a required amount of steam at a definite pressure. This formula is as follows:

$$d = 0.175\ (W \div y)^{\frac{1}{2}}$$

where d = the diameter of the pipe in inches

y = the density of the steam in pounds per cubic foot

w = the weight of steam flowing in pounds.

I have tried using this formula with the data given in the book but cannot get the same answer.

Chicago, Ill. W. A.

A. Your trouble probably results from a misunderstanding of the nature of the fraction ½ contained in the formula. This, as you will note is written as an exponent.

When a fraction is written as an exponent in this manner it means that a root has to be extracted from the term ahead of it. In this case

$$(W \div y)^{\frac{1}{2}}$$

means exactly the same as

$$\sqrt[2]{W \div y}$$

It is only another way of indicating that the square root of the term is to be taken.

If the fraction had been ⅓ instead of ½, it would have meant that the cube root was to be extracted.

Further information on this method of indicating the extraction of roots can be found in any good work on elementary algebra.

106

Water Treatment

Q. In our laundry we are using a sulphur water which we treat and filter and would appreciate any information you can give me on the treatment of water of this kind.

Coalinga, Cal. G. C. MILLS
Coalinga Steam Laundry

A. By sulphur water we assume you mean water with a high content of dissolved hydrogen sulphide or SO_2 which gives it a bad taste and odor. Dissolved gases of this kind are largely eliminated in a properly vented open type feedwater heater and quite completely in a deaerating heater.

Water which is not used for boiler feed could probably be treated effectively by proper aeration through a spray nozzle. Sulphur dioxide is sometimes used as a neutralizing agent following an over-chlorination treatment so that probably chlorine could be used if the difficulty were due entirely to SO_2 although this might be rather expensive.

This question was referred to the Elgin Softener Corp. for a more complete answer with the following result:

"We appreciate your inquiry of January 24th regarding your correspondence with an engineer in a California laundry on the subject of 'Water Conditioning involving sulphur removal.'

"Undoubtedly your surmise is correct, and the question refers to hydrogen sulphide. Where very small traces of sulphur are present, it can sometimes be adequately handled by means of activated carbon filtration, but where any appreciable amount is to be removed, atmospheric aeration has proved to be the most efficient and satisfactory method."

107

Capacitor Motor

Q. What is a capacitor motor? Do such motors correct for low power factor?

Portland, Ore. C. B.

A. No, capacitor motors do not correct for low power factor. A capacitor motor is simply a single phase motor that has a capacitor connected in one of its windings during starting. The arrangement used is shown in the accompanying drawings (Figs. 1 and 2). The two windings, one the running winding shown in full lines and the other the starting winding shown dotted, are in different sectors around the stator. The starting winding, the centrifugal switch and the capacitor are connected in series. The centrifugal switch is mounted on the rotor and is set to open at a predetermined speed.

The purpose of introducing the capacitor into the circuit is purely to provide a leading current in one of the windings, which will be displaced in time phase relative to the current in the main winding.

In order to obtain the rotating field necessary to develop starting torque, it is necessary that the currents in the two windings be displaced in time phase. In the case of the polyphase motor, this phase displacement is obtained by connecting the two electrically similar windings to two voltages differing in phase.

In the capacitor motor (and also in the split phase motor) the two circuits are connected to the same voltage, and the phase displacement of currents is obtained by a dissimilarity of the electrical constants of the two circuits. In the capacitor motor, the capacitor causes the auxiliary phase current to lead the main phase voltage, obtaining a large angle of displacement between the currents in the two windings. A vecter diagram of the locked currents of a typical capacitor motor is given in Fig. 3.

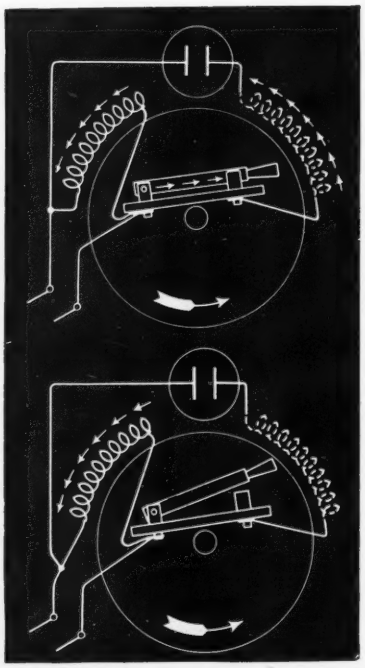


Fig. 1. The phase displacement, set up by the capacitor, of the currents in the starting and running windings, together with their physical displacement on the stator, produces a rotating magnetic field that starts the rotor

Fig. 2. When the rotor reaches a predetermined speed, the centrifugal switch opens the starting-winding circuit. Current flows only in the running winding, and the motor operates the same as an ordinary induction motor

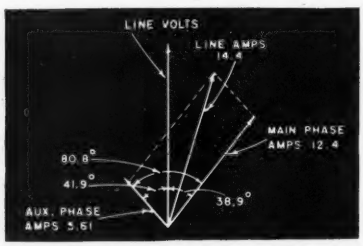


Fig. 3

108

Loss Due to Boiler Scale

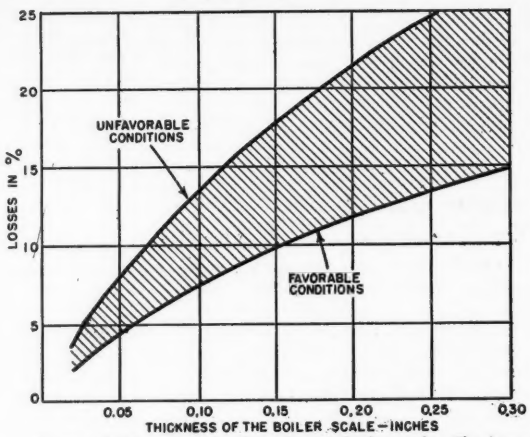
Q. What is the effect of boiler scale upon heat transmission? Is there a simple formula by means of which the heat loss due to scale can be calculated?

Laguna Beach, Cal. F. MCILWAIN

A. While the heat losses due to boiler control are fully appreciated, there is considerable difference of opinion as to the exact extent of the loss. A recent article in the Sulzer Technical Review, published by Sulzer Brothers, Switzerland, says that not only the design and construction of the boiler and the type of firing play a considerable part, the composition of the scale differs so greatly that investigations show wide discrepancies.

Increase in fuel jumps from 50 per cent and more have been blamed on mud and scale, but it is felt that these figures are exaggerated. Based on the results obtained from reliable investigations and many years of practical experience, their engineers prepared Fig. 1 showing the losses caused by the presence of scale in the boiler as complying fairly well with normal conditions.

The lower curve holds for the most favorable condition with a type of scale with comparatively little insulating effect, or when the greater part of the scale is deposited in zones where the rate of heat transmission is low. The upper curve holds for unfavorable conditions. General practical or normal value lie in the shaded part of the diagram. It shows that a layer of scale one tenth of an inch thick should show a loss of about ten per cent. The curve also shows what heat losses are to be reckoned with for other thicknesses of scale or mud.



Curves showing the heat loss due to boiler scale. The lower curve holds for the most favorable conditions, i. e., with a type a scale with little insulating effect. The upper curve holds for correspondingly unfavorable conditions

THIS picture will give you an idea how it feels to have Nalco end the nuisance of cleaning scale out of boilers, feedlines, pumps, condensers, etc. You feel like just sitting down and taking it easy. You need not worry about corrosion, foaming, algae, nor any of the other troubles that water may cause in power plant equipment. Later, when you get accustomed to the improvement, you will undoubtedly find that the time comes in mighty handy to take care of other jobs around the plant.

Nalco offers a complete water treating service. Adoption of the Nalco System requires no additional capital investment. Let us give you the facts—no obligation.

Nalco
- the Complete Water Treating Service

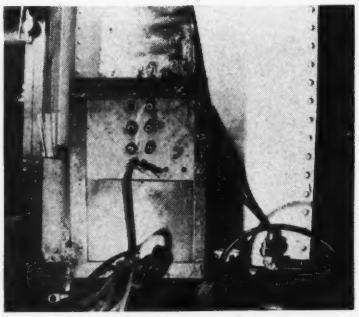
NATIONAL ALUMINATE CORPORATION, 6224 West 66th Place, Chicago, Ill.

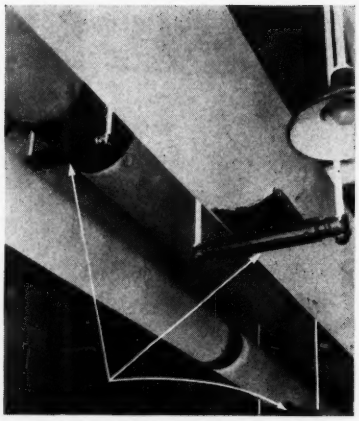
Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

SHOP TALK

A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

ELECTRIC WELDER — The electric welder shown at the right was made by Leslie Bradley in his plant at Bismarck, N. D., from the core of an old power transformer. This was wound so as to give proper arc voltage. It is made, as much as possible, from old material on hand and cost about $15.00, most of which went into the electrode holder, shield and cable. The welder has been used on piping from ½ in. up to 12 in., all types of structural steel and various jobs around the power plant. Incidentally, the use of this welder made a saving over gas welding; in the two years they have used it sufficient to more than pay for a good arc welder. As shown the entire outfit is mounted on casters so as to make it easily portable. Receptacles on the front panel board provide the various voltages.



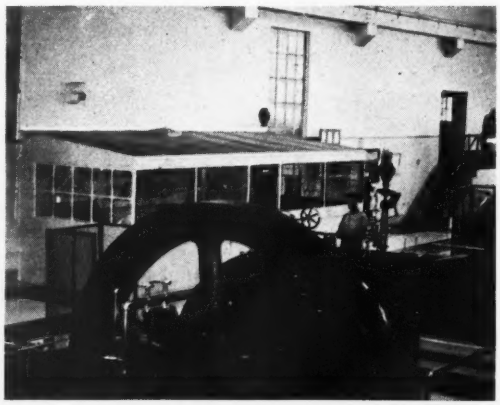


ROLLER BEARINGS — The American Viscose Corporation has installed tapered roller bearing conveyor tubes as supports for their hot water lines at their Front Royal, Va., Plant. The steam line supports in another American Viscose Plant at Nitro, W. Va., are also equipped with tapered roller bearings.

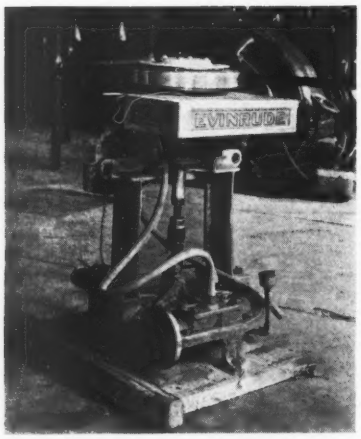
The bearing mounting consists of a conventional Timken conveyor tube, 8 in. long, equipped with Timken roller bearings and appropriate inner and outer seals at each end of the tube. Adjustment of the bearings is obtained through collars placed over the shaft and locked by means of two set screws. The bearings were packed at assembly with a light-to-medium consistency lime base grease.

These are believed to be the first applications of this type. They provide positive assurance that line expansion will be properly handled. The ease of rolling afforded by the bearings permits the pipe expansion to take place with the minimum of effort and precludes any extraneous loads being put into the line as the expansion and contraction take place.

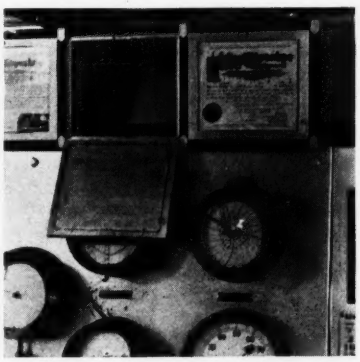
SOLID COMFORT — B. H. Whitehouse, chief engineer of the Milwaukee County House of Correction, didn't like the chilly draft that blew across his desk in winter, nor the flies that came in the summer. Now he has a new office built around the desks. The glass ends cut off the cold draft and the screens in front keep out the flies without obstructing the view of the instruments on the board inside.



LICENSES—Where to put licenses where they will be visible, convenient, kept clean and easily changed is another problem which B. H. Whitehouse solved in his plant by means of these frames above the instrument panel. Each frame is independent with a solid wooden bark which keeps the license flat and clean. They can be reached handily from the floor and a license changed in a few moments.



A BIT OF A MYSTERY—We moved a few months ago and in cleaning out one of the old desks found this unidentified photograph. Apparently the engineer sneaked down to the boat house one night, borrowed an outboard motor and fitted it onto a pump for portable use. Judging from the condition of the wooden base it was used as an acid pump for cleaning out the engine jackets. Perhaps some reader can identify the plant and tell definitely what the pump was used for, because the idea itself seems to have merit. The negatives are of a size which has not been used in the office for many years and while it is not evident in this view, other pictures show it to be a Diesel station with at least two good sized units.

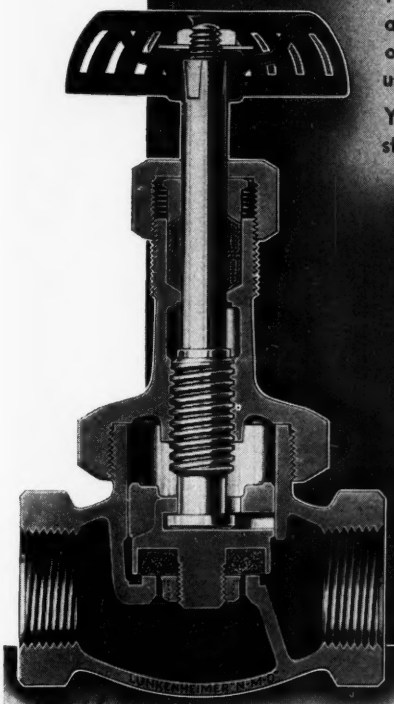


TAKE A Fig. 123 "N-M-D" Valve Apart

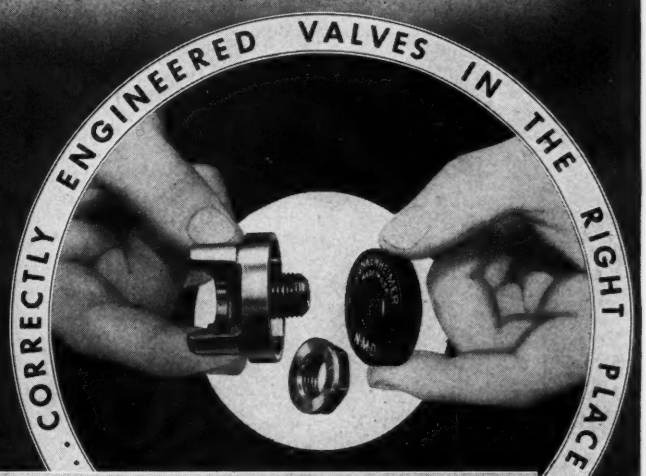
COMPARE IT POINT BY POINT

Take a Fig. 123 "N-M-D" Valve in your hands—get its feel of sturdiness and ruggedness—take it apart and compare it point by point with any other similar type valve—then you'll see why so many discerning valve users have switched to Fig. 123 for general service requirements.

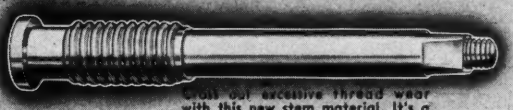
Your Lunkenheimer distributor will help you make this convincing demonstration. Just call for a Fig. 123 "N-M-D" Valve—then *you* be the judge.



300 lb. W.O.G.

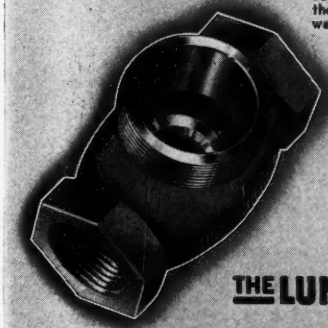


Disc can be renewed in a jiffy. The quickest way is to keep a few extra holders on hand with new discs inserted. Slip the holder with worn disc off the stem, replace with one of the extras, and the valve is again ready for service.



Cross out excessive thread wear with this new stem material. It's a recent Lunkenheimer development that gives five to ten times more wear resistance.

Ever have to pry a gland out of the stuffing box? Then you'll appreciate this hexagon head gland. Just apply a wrench — no prying necessary.



Note the well-proportioned body and full flow areas. And that heavy body neck is made to withstand distortion.

Slightly opening the valve prevents disc holder from dropping off stem when disassembling valve. Entire trimming assembly can be held in one hand.

Accurate disc guiding means accurate seating. This disc holder has *four* long guides always in contact with the body neck. Holder carries disc straight and true to its seat.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

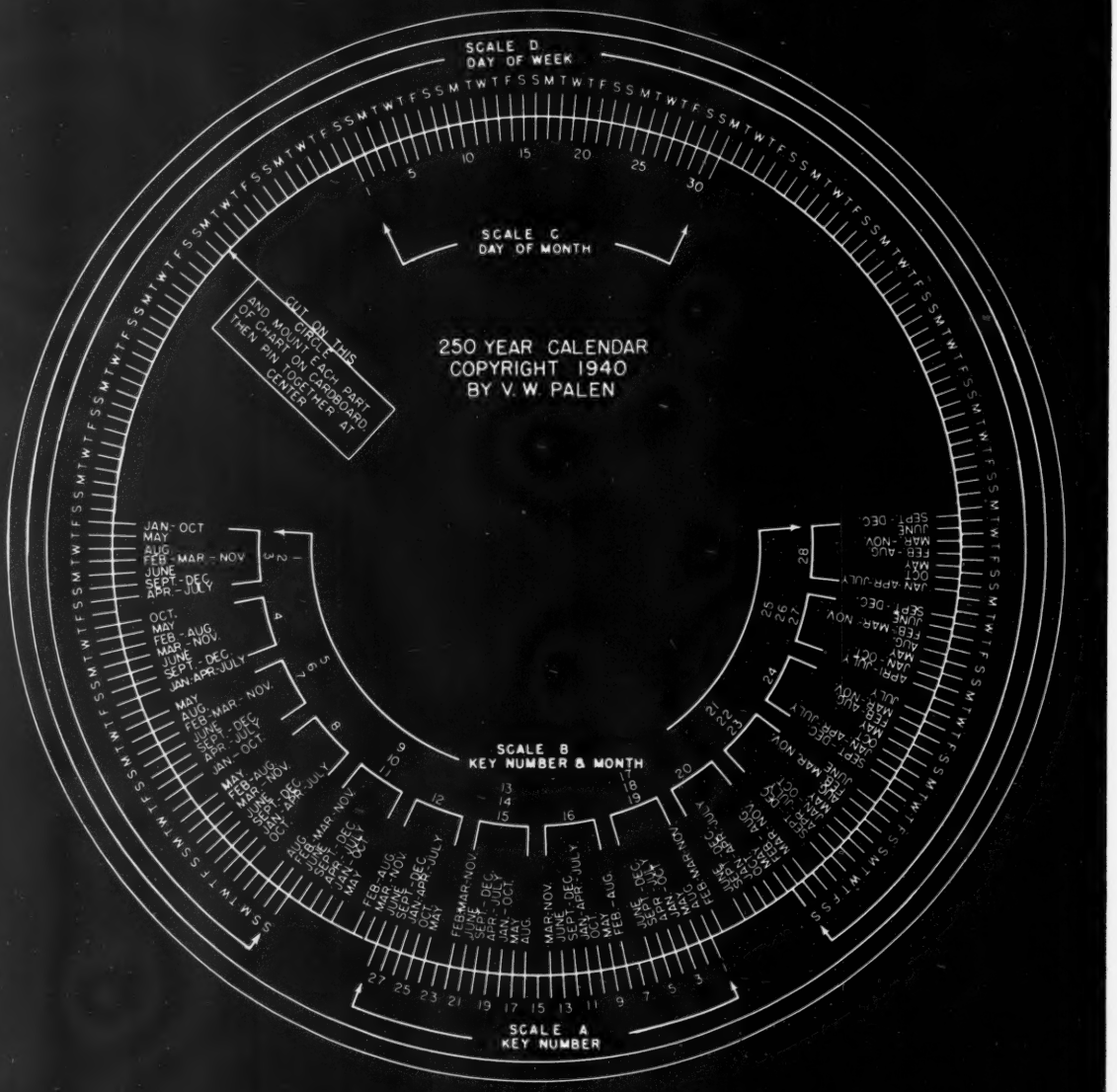
CINCINNATI, OHIO. U. S. A.

NEW YORK CHICAGO
BOSTON PHILADELPHIA

EXPORT DEPT 318-322 HUDSON ST., NEW YORK

LUNKENHEIMER

Send for copy of our new Catalog No. 78. We will include our handy "Guide", for easy selection of valves, boiler mountings, and lubricating devices according to pressures, temperatures, and service applications.



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19TH CENTURY	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
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	89	90	91	92	93	94	95	96	97	98	99	2000																

HOW TO USE CALCULATOR

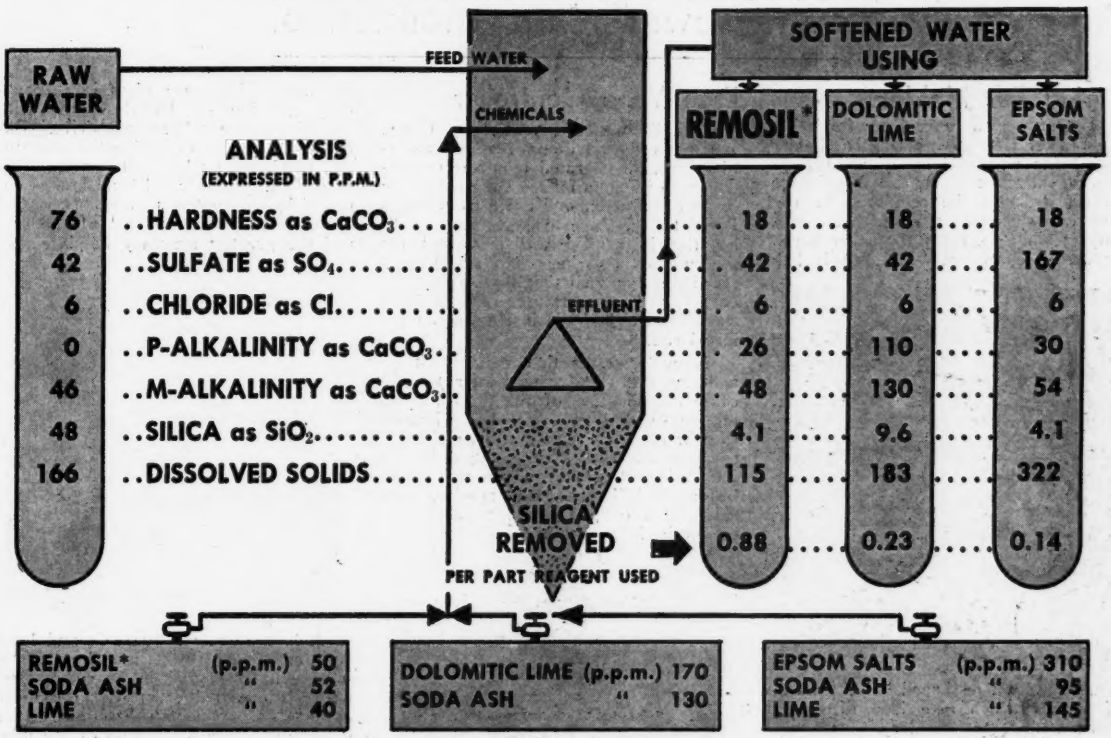
FIND THE YEAR IN WHICH YOU ARE INTERESTED IN THE ABOVE TABLE. THEN NOTE THE KEY NUMBER AT THE TOP OF THE COLUMN IN WHICH THIS YEAR APPEARS. APPLY THIS KEY NUMBER TO THE CALCULATOR.

FOR INSTANCE THE YEAR 1776 HAS A KEY NUMBER OF 8. SET 8 ON SCALE A OPPOSITE JULY (UNDER 8) ON SCALE B. NOW NOTE THAT OPPOSITE THE 4TH DAY OF THE MONTH (SCALE C) WE READ "T" (THURSDAY) ON SCALE D. THUS THE 4TH OF JULY, 1776 WAS ON A THURSDAY.

THE PRESENT STYLE CALENDAR WAS ADOPTED BY ENGLAND AND HER COLONIES IN 1752. THEREFORE THE ABOVE TABLE BEGINS WITH THE YEAR 1753.

INDISPUTABLE
FACTS ABOUT SILICA REMOVAL

A GRAPHIC COMPARISON OF FACTS ESTABLISHED BY ACTUAL ANALYSES


RAW WATER
FEED WATER
CHEMICALS
EFFLUENT
SOFTENED WATER USING
REMOSIL*
DOLOMITIC LIME
EPSOM SALTS
ANALYSIS
(EXPRESSED IN P.P.M.)
76 ..HARDNESS as $CaCO_3$ .... 18 .... 18 18
42 ..SULFATE as SO_4 .... 42 .... 42 167
6 ..CHLORIDE as Cl .... 6 .... 6 6
0 ..P-ALKALINITY as $CaCO_3$ .... 26 .... 110 30
46 ..M-ALKALINITY as $CaCO_3$ .... 48 .... 130 54
48 ..SILICA as SiO_2 .... 4.1 .... 9.6 .... 4.1
166 ..DISSOLVED SOLIDS .... 115 .... 183 322
SILICA REMOVED PER PART REAGENT USED
0.88 .... 0.23 .... 0.14
REMOSIL* (p.p.m.) 50
SODA ASH " 52
LIME " 40
DOLOMITIC LIME (p.p.m.) 170
SODA ASH " 130
EPSOM SALTS (p.p.m.) 310
SODA ASH " 95
LIME " 145

THE COMPARISON OF ANALYSES SPEAKS FOR ITSELF—LET'S REVIEW THE HIGHLIGHTS

REMOSIL*

1. No increase in amount of lime or soda ash used.
2. No increase in hardness or alkalinity of softener effluent.
3. An efficient coagulant.
4. Solids are actually decreased.
5. Highly EFFICIENT in quantity of Silica removed per unit of reagent employed.
6. Simplified feeding. Added to lime and soda ash to same feeder without special precautions.

DOLOMITIC LIME

1. May reduce lime requirements, but in many cases (as noted) the excess calcium oxide added requires more soda ash for its removal.
2. In such cases, exceedingly high alkalinities of softener effluent cannot be avoided.
3. Increased solids shown.
4. Relatively INEFFICIENT in quantity of Silica removed per unit of reagent employed.
5. Special procedure for slaking or special equipment for feeding may be required.

EPSOM SALTS

1. Requires larger quantities of lime and soda ash.
2. Solids are greatly increased by formation of sodium sulfate.
3. High cost for Silica Removal.
4. Relatively INEFFICIENT in quantity of Silica removed per unit of reagent employed.

***THE BETZ ADSORPTION PROCESS USES REMOSIL—A DISTINCTIVE MAGNESIUM OXIDE**

Although the above comparisons prove conclusively the superiority of Remosil for Silica Removal, by a wide margin, the example is an average case and by no means the most pronounced difference on record. Remosil removes far more Silica per unit of reagent than any other commercially available chemical. Unlike other reagents, which increase other solids while removing Silica,—Remosil decreases other solids. Complete details are reprinted in Technical Bulletins Nos. 63 and 64—from papers presented before the American Chemical Society.

It will pay you to write for FREE copies—NOW—while you think of it.

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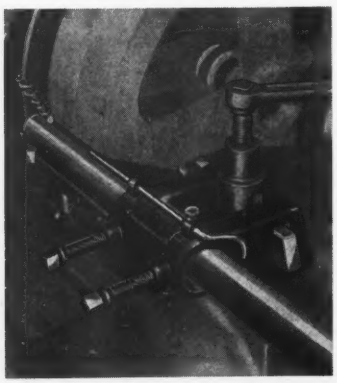
New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Boring Bar Holder

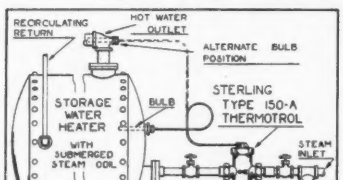
DESIGNED as a convenience for lathes, the Walker Hole Hog boring bar holder, now being marketed by National Engineering Products, Inc., Washington, D. C., straddles the regular lathe tool post and is clamped down with the ordinary turning tool ready for either boring or facing operation. The bar is held



firmly in a wedge-shaped hole by means of screws which give it a three-point bearing. The tool holder is convenient for reaching surfaces that cannot be touched with the ordinary turning tool and it can be used for boring operations or, as illustrated here, for outside turning. It is provided with a gage which can be adjusted quickly for boring, threading, chambering and counter-boring to a shoulder.

Steam Flow Control

SELF-CONTAINED and self-powered Thermotrols for regulating flow of steam or water to storage tanks, drying ovens, oil preheaters and the like are a new product of Sterling, Inc., Milwaukee, Wis. No. 150A is for pressures from 0 to 30 lb. per sq. in. in sizes ½, ¾ and 1 in. No. 150AH is for pressures up to 125 lb. per

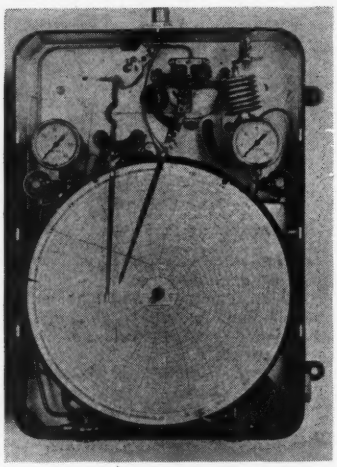


sq. in. in the same sizes. Control is by pressure generated in a thermal bulb placed in tank or pipe line and operating a bellows in the valve housing to open or close the ball valve. Regulation of control is by an adjusting screw in the valve which changes compression on a spring opposing the fluid pressure.

Free Vane Controller

THE BRISTOL CO., Waterbury, Conn., announces the addition of a new throttling-type, air-operated temperature controller to its line of Free Vane automatic control instruments. Known as Bristol's Pre-Set Free-Vane temperature controller, this instrument was developed for use on processes where the thermal characteristics are such that there is a tendency for the temperatures to exceed the control setting of the instrument on the initial rise.

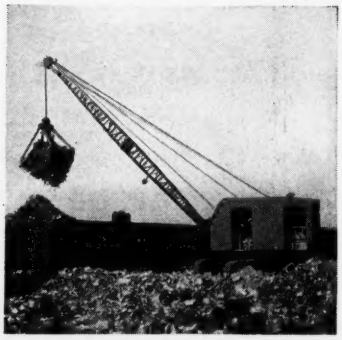
Many processes that are started up and shut down at frequent intervals will cause overshooting of the control point on the starting up cycle, due primarily to slow rate of circulation and resistance to heat transfer. An example is the jacketed cooling unit where the jacket has appreciable mass and requires considerable cooling medium to arrive at the desired temperature.



The controller introduces a presetting effect, proportional to the width of throttling range and also rate of change of the condition being measured and controlled. Controller action occurs prior to or during the approach of the pen to the control point, tending to decrease the rate of change of position of the pen and permitting the controlled temperature to approach the control point gradually. Magnitude and duration of the presetting effect may be controlled over a wide range by adjustment of a pointer on an arbitrarily calibrated dial.

Convertible Shovel

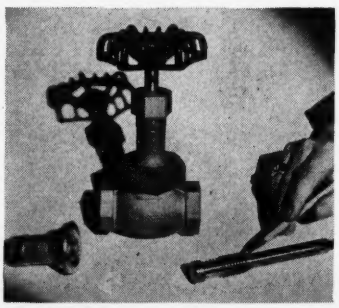
ALL-WELDED steel construction has replaced castings in a new, lightweight ¾-yd. convertible shovel-dragline-crane, Model 75, announced by Link-Belt Speeder Corp., Chicago, Ill., as a companion to its LS-85 heavy-duty ¾-yd. machine. The power plant is a heavy-duty gasoline or Diesel engine with smooth-running roller chain drive. External band clutches enable the operator to "feel" the load at all times. This sensitivity, plus external band brakes operated by automotive type pedals, is said to result in perfect control of the load and the greatest accuracy in placement.



A large-diameter turntable and long, wide crawlers give this model extra stability on slopes and in heavy digging. Controls operated from within the cab permit steering in both directions, either gradual or sharp, regardless of the relative position of cab and lower base. A positive traction lock, controlled from the cab and engaging in three positions, prevents movement of the crawlers while working, eliminating any necessity for chocks or blocking.

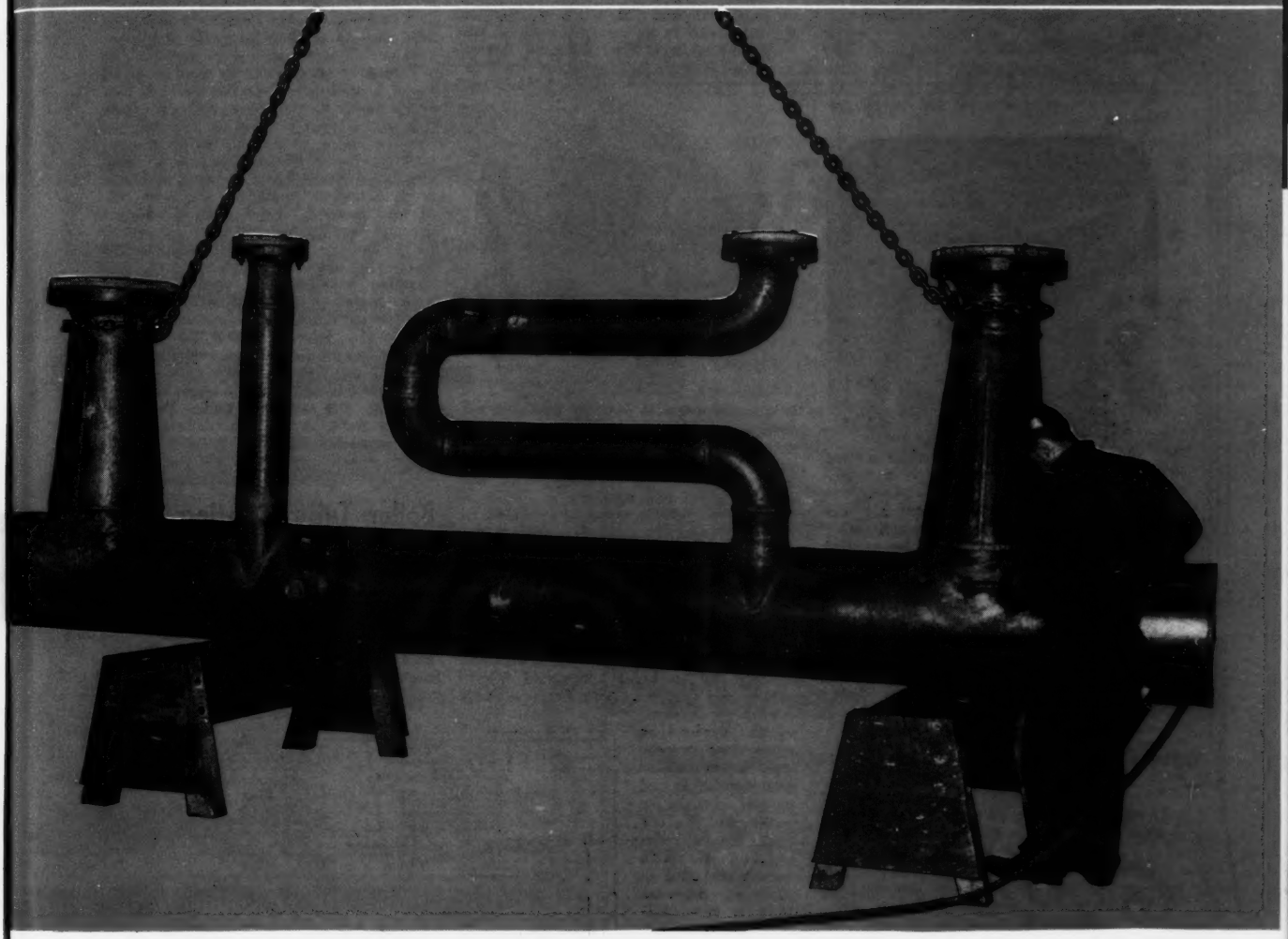
Valve Stems

THE Hancock Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces Hancodur, a new, long-wearing alloy, for valve stems and bonnets, which was developed expressly for use in Hancock Superfinished 500 Brinell bronze valves.



They have a tensile strength of 90,000 psi with a self-lubricating characteristic that resists galling and wear. Full line of Hancock Superfinished 500 Brinell bronze valves are now furnished with these stems and bonnets.

To Help You Meet "TIGHT" EXPANSION SCHEDULES...



Interpretive Engineering by Grinnell may cut weeks from super-piping installation!

IF the problem of extending your power or process facilities *fast enough* seems insurmountable, investigate this engineering and prefabrication service that is helping other hard-pressed manufacturers today!

As soon as the requirements of your welded piping systems are roughed out, "give the plans to Grinnell". Through long experience in equipping power and process industries, Grinnell specialists have unusual ability to interpret exacting layouts into complete modern super-piping systems.

Grinnell plants strategically located throughout the country then prefabricate the job with the most advanced equipment, under time-saving shop conditions. Promptly on delivery date, accurate sub-assemblies bearing underwriters' approval are on the job . . . ready to hook up with minimum field welding!

Write for complete manual on this speedy service, "Grinnell Prefabricated Piping". Grinnell Company, Inc., Executive Offices, Providence, Rhode Island. Branch offices in principal cities.

PREFABRICATION BY **GRINNELL**

WHENEVER **PIPING** IS INVOLVED

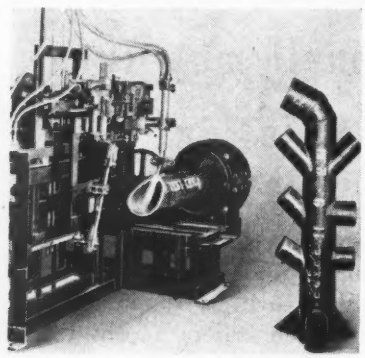
Scientific Odor Control

A NEW scientific odor control has recently been announced by the W. B. Connor Engineering Corp., New York, N. Y. Being the new outside air introduced that requires the bulk of the conditioning energy, all economically planned systems are designed to recirculate a maximum of air, but this control is limited to the health and comfort of the occupants, which requires from 15 to 30 cu. ft. of pure, odor-free air per minute per person.

Dorex Odor Adsorbers, when applied to the recirculated air, permit a reduction in the outdoor air supply to 3 to 5 cu. ft. per minute per occupant, thus reducing air conditioning costs. These adsorbers may be applied to existing as well as to new air conditioning systems. They are the commercial application of the gas mask principle. Employing specially processed, highly activated coconut shell carbon, they extract and hold odorous gases and vapors in a condensed state. Upon saturation, the carbon may be economically reactivated and reused.

Pipe Intersection Cutter

SPENCE ENGINEERING CO., Inc., Walden, N. Y., recently announced its new Fall-O-Matic Universal Pipe Intersection Cutter. This machine is said to cut any size pipe to fit any pipe of the same size, or larger, at any angle or any offset. Illustrated at the right of the machine is a sample of the work that it does. The cutting is done by a standard cut-

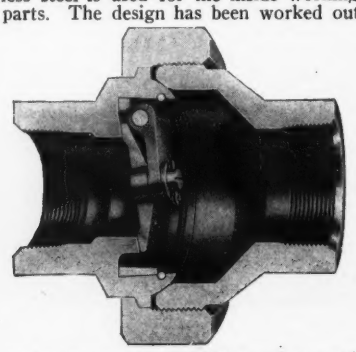


ting torch. Adjustments are made by four dials, two of which can be readily seen at the top of the carriage.

The machine is hand operated because the compound motion changes the cutting speed to such an extent that the operator must gage the speed to match the torch's ability to cut. It takes less than 5 min. to set up and make the cut.

Union Type Check Valve

FOR HIGH pressure boiler feed lines and heavy duty service, a new union type check valve has been developed by the Central Forging Co. of Catawissa, Pa. Forged steel is used in the construction of both ends and nut, while the seat in the male end is an integral part of the body formed from the solid steel. Stainless steel is used for the inside working parts. The design has been worked out



to give the greatest possible unobstructed flow, and for 600 lb. working steam pressure or 1500 lb. oil, water or gas pressure. Opening the union nut opens the line, eliminating the necessity of an additional union and nipple.

This type check valve is available in three different designs: No. 600 as described above, No. 601 equipped with a Catawissa union forged steel nut, and No. 602 for corrosive and acid conditions with all inside parts made of stainless steel.

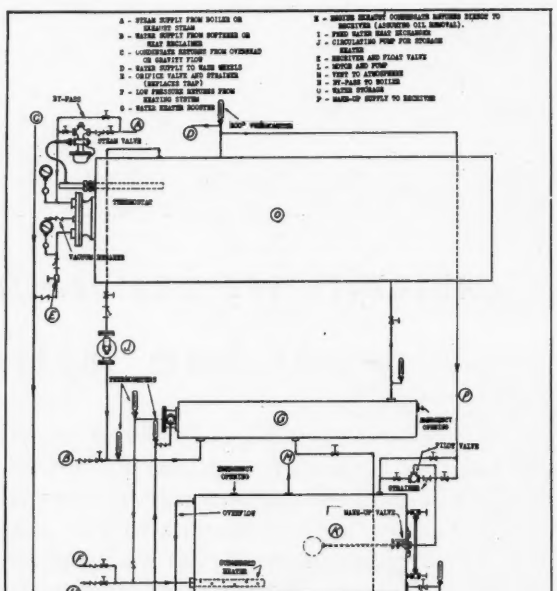
Heat Reclaim System

FRED H. SCHAUB Engineering Co., Chicago, Ill., recently announced a system known as the Schaub Trapless Heat Reclaim System, which embodies condensate recovery, boiler water level regulation and control of make-up water and boiler feed. Specially designed orifice valves are used in place of traps to return condensation from steam using equipment to the receiver. To recover flash heat from the condensate, a heat exchanger is introduced, which delivers the flash heat to the feedwater on its way to the boiler, thus practically eliminating escape of flash steam from the receiving vent.

Connections of the system are shown in the illustration. For condensation recovery, low pressure returns enter receiver K through connections F and H, the submerged heater distributing heat to receiver contents. High pressure returns are delivered at C and pass with condensate from coils in storage tank O coming through orifice valve E, to heat exchanger I. This valve E, with orifice selected for drainage required, and other like valves are used in place of traps on all high pressure condensate return lines.

Condensate from receiver I passes to heat booster G, then joins the low pressure condensate to enter receiver K. Where a storage heater is used as at O, water is circulated between tanks G and O by pump J, with thermostat controlling steam supply from S through the steam valve to hold water in the storage tank at the desired temperature. Discharge of water from G joins discharge from K and is carried to the inlet side of feed pump L. Feed pump discharges through heat exchanger I, or bypass N, to the boiler. Water level is controlled by a Magnetrol device, with float in a chamber connected in parallel to the boiler water column, and activating electric connections to start or stop the feed pump; also interconnection for pressure control has an electrical circuit for starting and stopping fuel supply.

Similar arrangements may be made omitting the storage tank, the heat booster tank, or both, according to requirements of the heat balance of the plant.



Boiler Tube Coating Machine

FOR APPLYING protective coatings to the interior of boiler, economizer, condenser and other accessible tubing, the Dampney Co. of America, Hyde Park, Boston, Mass., has developed a new automatic tube coating machine reported to reduce tube coating time and improve quality and uniformity of coverage.

DO YOU NEED POWER CABLE NOW?

HERE ARE 372 ITEMS YOU CAN GET RIGHT OFF THE SHELF

DELIVERIES today on 'most everything are becoming more and more important, and that applies of course to insulated power cable. You can save a lot of time by ordering stock items.

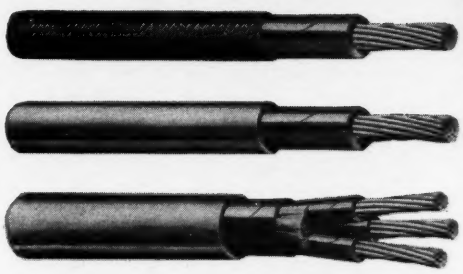
Here are four lines—selected because they have become G-E standards and are tops in their respective fields—and because we can supply some 372 different items from stock, *right off the shelf.*

There are also hundreds more—apparatus leads, switchboard wire, line wire, control cable, and others—and we'll gladly give details.

From the data shown here, you can get an idea of what are available and can judge if any of these standard items will meet your requirements. For current prices and more details, call or write the nearest G-E office or G-E distributor. Or see the new *Cable Digest,* which has application data, approximate prices, and a section, "How to Select Conductor Size," based on the 1940 N. E. Code. Ask for Bulletin GEA-3280. General Electric Company, Schenectady, New York.

1. NO. 1799 VARNISHED-CAMBRIC

SAVE TIME



A proved performer—with a 40-year outstanding service record. Excels on dielectric strength, is suited for high voltage. Cable can be operated at 85 C—on heavy currents, saves copper.

Where to use: for power feeders.

75 ITEMS IN STOCK

Single-conductor
600, 3000, and 5000 volts—braided and leaded

Three-conductor
600, 3000, and 5000 volts—leaded

2. VERSATOL* BRAIDED POWER CABLE

Insulation has a water-absorption factor of 0.010 gram per sq in.—cable needs no lead sheath. Operating temperature, 75 C—highest for rubber. Oxygen-bomb aging, 504 hours—approximates 50 years' natural life.

Where to use: for general-purpose wiring.

*REG. U. S. PAT. OFF.

20 ITEMS IN STOCK

Single-conductor
600 volts, braided
(See also tellurium parkway)

SELECT STANDARDS

"It must . . . be remembered that standard lines have become standard because they have on the whole performed best . . . Furthermore, every order for special equipment, where standard would have done, takes just so much production time away from some other order that is needed for defense. Thus, specials defeat their own purpose and help to slow up the defense program."

ELECTRICAL WORLD Oct. 5, 1940

INSULATED CABLE ALWAYS RIGHT

3. FLAMENOL*—SELF-PROTECTED

An outstanding G-E synthetic-insulated cable. Needs no protective finish. Resists oil, acids, alkalies, moisture, and flame. Operating temperature, 60 C.

Where to use: for all low-voltage jobs where wiring must meet extraordinary conditions.

*REG. U. S. PAT. OFF

150 ITEMS IN STOCK

Single-conductor
600 volts, 12 colors. More sizes of black are carried in stock than of any other color.

4. TELLURIUM

With jacket of 60% new rubber, cured with tellurium. TOUGH—will last for years

PORTABLE
For all types of portable electric equipment

PARKWAY
For direct burial in ground, for use in ducts and in other places

76 ITEMS IN STOCK

Superflexible arc-welding cable
600 volts—single-, 2-, 3-, and 4-conductor
2500 volts and above—3-conductor, Type G

51 ITEMS IN STOCK

With 30% rubber or Versatol insulation
600 volts—single-, 2-, and 3-conductor
2500 and 5000 volts, single-conductor
5000 volts, 3-conductor

GENERAL ELECTRIC

This automatic feed-to-brush equipment consists of a pressure-feed Apexior container equipped with adjustable coating-pressure regulation. It operates with air-motor agitation, a single air-fluid line and forced feed to the expanding brushes through a specially constructed air turbine. With operating hose lengths up

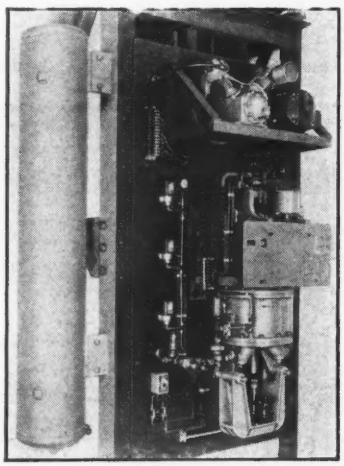
to 150 ft. or more, connected to a working line up to 75 ft. long, the operator is able to pass the brush head all the way through the tube. The coating is discharged into the path of the rotating brush as the coating unit is withdrawn.

This method is said to help the handling of long horizontal, bent or vertical tubing, with considerable savings in labor and material.

Pneumatic Operator for Circuit Breakers

DEVELOPMENT of a pneumatic operator for the high-speed operation of large outdoor oil circuit breakers is announced by Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

The new operator, designated type PN-700, is especially suitable for fast reclosing service, reclosing times within 20 cycles (60 cycle timing) having been



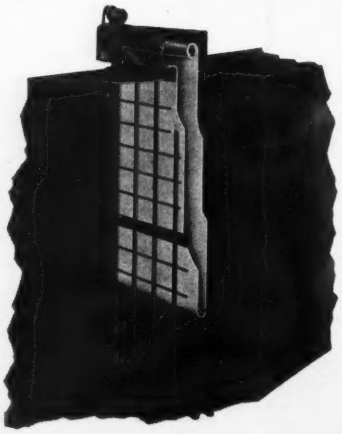
obtained when using the PN-700 in conjunction with a standard 69 kv., 600 ampere, 500,000 kv-a. outdoor oil circuit breaker. The type PN-700 is also particularly suitable for installations where a D.C. supply is not available, and where operation from an A.C. source through a rectifier is not considered desirable.

The type PN-700 consists essentially of an air cylinder and piston, and a mechanically trip free mechanism. It uses a normal operating pressure range from 80 to 125 lb. per sq. in. An auxiliary compressed air storage tank stores enough air for three closing operations before recharging is necessary.

Auxiliary devices include: a small electrically driven air compressor, for recharging the breaker tank, operated from a 220 Volt A.C. single phase source; an automatic pressure control switch for starting and stopping the compressor and maintaining pressure in the air tank within pre-determined limits; a low pressure lockout switch; a low pressure bell alarm switch; a safety valve; an air cleaner; a pressure gauge and auxiliary switches.

Damper

HEACON, INC., Philadelphia, Pa., recently announced a curtain type damper. Six years service in units rated from 40 hp. to 300,000 lb. per hr. have developed a design reliable for temperatures to 1,000 deg. F. A tight seal is accomplished when the draft holds the curtain against sealing strips. Ample clearances are provided as seal is not dependent on tight fit and binding is eliminated. Lower draft loss increases capacity and saves fan power. Draft reduction resulting from leakage from cold boilers is prevented. Economizers, air heaters,



dust catchers and fans can be isolated for maintenance while balance of unit continues to operate. Any desirable flow characteristics can be supplied by V-porting, thus giving accurate control of flow over wide range, increasing efficiency and range of output either manually or automatically controlled. Loss of heat during banking is minimized and flow of air to fuel bed or furnace is prevented. Sealing of bypasses saves heat and fan power. It conserves space in new units and will fit most old units with a minimum of alteration. It is available for vertical, inclined or horizontal applications and for positions where flow is reversed.

Electric Drill

SNAP-ON TOOLS CORP., Kenosha, Wis., recently added a new ½ in. capacity electric drill to their present line. Compact, streamlined and modern in every detail, this bluepoint drill has its pistol grip centered below the body and its rear handle placed at right angles to the pistol grip in order to give additional control and ease of handling.

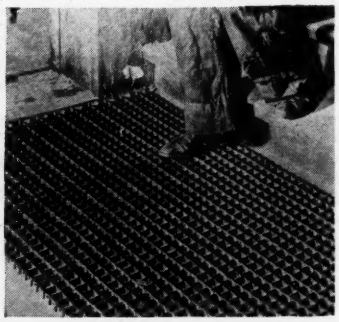
High-grade ball-bearings are used on the armature shaft and chuck spindle and needle roller bearings on the gear shafts. Smooth, powerful torque is provided through a double-reduction gearing. The motor is a powerful universal

type with statically and dynamically balanced armatures; operates on a.c. or d.c. up to 60 cycles and is cooled by a balanced fan mounted on the armature shaft; an air direction baffle increases the fan efficiency. No-load speed is 450 r.p.m., full load speed 300 r.p.m.

Virgin aluminum alloy is used for the die cast housing to insure ample strength and minimum weight. This tool weighs only 8 lb. and has a drilling capacity of ½ in. in steel and 1¼ in. in hard wood.

Safety Steel Floor Mat

WITH SAFETY, cleanliness, flexibility and non-skid qualities, the new steel mat manufactured by the Wm. F. Klemp Co., Chicago, Ill., is well adapted for use in many power plant locations. The mat is made from ⅝ in. x 0.065 in. special



analysis steel and formed into a 1¼ in. x 1¼ in. mesh. When the mat is unrolled, it lies flat and rigid and will not creep or wrinkle.

Mats can be furnished cut to any length up to 25 ft., any width up to 6 ft., and are supplied in multiples of these dimensions.

Reduction Drive

INTRODUCTION of an entirely new type of speed reducer has been announced by The American Pulley Co., Philadelphia, Pa. This new equipment consists of two major elements; a helical-gear reduction unit which mounts directly on the shaft of the driven machine and a standard belt drive between the motor and the input shaft of the reduction unit. The unit itself has a standard, fixed ratio of

Spray-Spred FIRING METHOD

EXCLUSIVE WITH Fyr-Feeder

IS REVOLUTIONIZING COAL BURNING . .

NOW A TWO UNIT Fyr-Feeder

MODEL R 4072
200 D. H. P. CAPACITY

Only $995

F. O. B. FACTORY
CONTROLS EXTRA

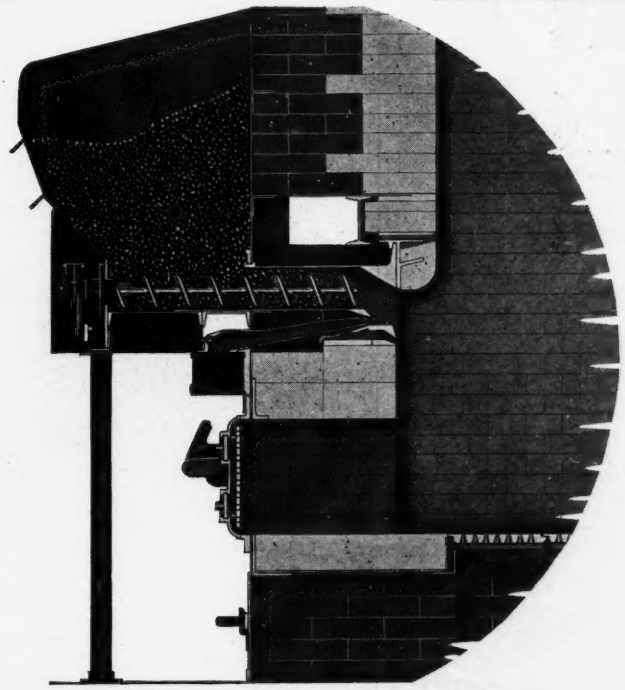
OTHER SIZES IN PROPORTION

Sets a new high in Cost Savings

★ FYR-FEEDER is THE outstanding Spreader Stoker and THE one which mechanically carries the coal through the front furnace wall—to inclines inside the furnace. From there it is Spray-Spred uniformly and according to the weight-size of each piece, over the grate, by means of double purpose air streams. The larger coal sizes are placed near the front—the smaller pieces to the rear—the fines burn instantly in suspension producing complete, efficient combustion. The same air which Spray-Spreds the coal—burns the coal fines in suspension. The FYR-FEEDER efficiently burns bituminous screenings, yard sweepings, or coal dust, wet or dry.

The Multiple FYR-FEEDER is up-to-the-minute—most modern and extremely practical.

AMERICAN COAL BURNER COMPANY
151 E. Superior St., Chicago, Ill.
Builders of Over-feed Stokers for Over 22 Years



WHY the Fyr-Feeder will save money for you . . .

- Ability to Burn Cheapest Coals
- Improve Combustion
- Lower Maintenance
- Lower Operating Costs
- Reduce Banking Losses
- Less Maintenance of Refractory
- Less Unburned Carbon in Ash
- Quick Pick-up—Quick Operation
- Easy to Clean Fires
- Flexible Precision Coal Feed

EACH INSTALLATION IS SUPERVISED AND PLACED IN OPERATION BY A COMPETENT COMBUSTION ENGINEER.

Installation in Midwestern State

H.R.T. boiler, 54"x14' (brick sidewall setting), formerly hand-fired, burned 350 tons of coal annually, $6.50 per ton. Steam pressure was very irregular. Firing required a great deal of attention.

Installed a two-unit Spray-Spred FYR-FEEDER. Now use coal costing only $2.25 per ton and owner reports they burn no more than when the more expensive coal was used. Large Coal Dollar Savings. FYR-FEEDER investment pays out quickly.

Plenty of steam now. Uniform pressure. FYR-FEEDER requires practically no attention. Saves money on banking fires. Cleaning fires is no work at all. Owner now enthusiastic FYR-FEEDER user.

Installation in Eastern State

Modern 200 hp. water tube boiler formerly fired with Pulverized Coal.

Installed a six-unit Spray-Spred FYR-FEEDER. Now burn less coal and cheaper coal. Savings on electricity, gas, maintenance and attendance. Total savings amount to many thousands of dollars each year. Owners well pleased with FYR-FEEDER and high return on small investment involved.

Installation in Central State

H.R.T. boiler, 60"x16', formerly fired with underfeed stoker. Burning approximately 600 lbs. coal per hour.

Installed a two-unit Spray-Spred FYR-FEEDER. Now use coal costing $1.00 less per ton. Coal bills reduced. Always plenty of steam at uniform pressure. Maintenance now practically eliminated. Owner pleased by change-over to FYR-FEEDER.

Installation in Northern State

Modern 400 hp. water tube boiler. formerly fired with underfeed stoker. Normally operated at 150% of rating, with peak loads 175%.

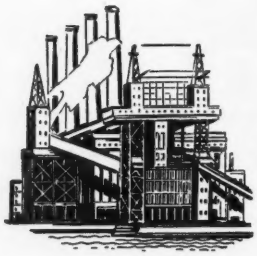
Installed a six-unit FYR-FEEDER. Now, normal operation 250% to 275% of rating. Peak loads 325% of rating. FYR-FEEDER installation and performance most efficient and satisfactory.

Spray-Spred MULTIPLE **Fyr-Feeder**

REDUCES COAL BILLS - - BURNS CHEAPEST COAL SIZES

★ THERE'S A BELMONT PACKING FOR EVERY SERVICE ★

For
STEAM



The defense program demands uninterrupted service of power plant equipment. Engines and pumps *must* be kept operating at maximum capacity, sometimes twenty-four hours a day—no time for frequent packing replacements.

Here are offered two standard Belmont Packings that *will* withstand the strain—Belmont 30 for reciprocating steam rods and Belmont 754-P for rotating steam shafts. TRY THEM NOW!

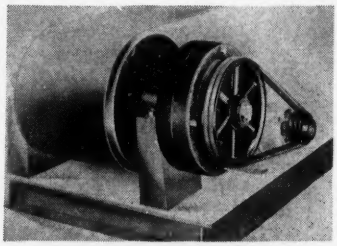
Write on your company letterhead for Belmont Catalog No. 40 which describes Belmont Packings for all services—a text book guide on applications. An authorized Belmont distributor will be glad to show you samples and help you with *your* particular requirements.

BELMONT
PACKINGS

FOR RECIPROCATING STEAM RODS
BELMONT 30
For reciprocating steam rods where boiler pressure is in excess of 100 pounds, (340 degrees F.)
FOR ROTATING SHAFTS
BELMONT 754-P
Practical and reliable for rotating shafts, all temperatures.

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

13 to 1, any greater or lesser ratios being accomplished by the primary belt drive. For example, where an overall reduction ratio of 52:1 is desired, a belt drive is selected with a ratio of 4:1. This ratio, in combination with the ratio of the reduction unit, delivers precisely the speed desired.



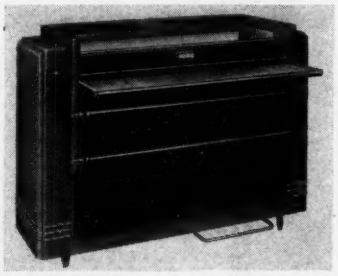
Five reduction units, each with the same 13:1 ratio, cover all applications from ½ to 30 hp. Therefore, any desired speed between 11 and 215 r.p.m. can be provided with standard, stockable equipment. For speeds lower than 11 r.p.m. special reduction units can be assembled.

Because the "American" reduction unit mounts directly on the shaft as easily as a conventional pulley, no space or expense for special foundations is required. The shock-absorbing action of the primary belt drive protects the gears from any shock loads, thus greatly prolonging the life of the unit. Necessary maintenance attention is confined to infrequent lubrication.

Printing Machine

SIMPLICITY of design and operating usefulness are embodied in a new printer just announced by Charles Bruning Co., Inc., New York, N. Y. Known as the Model 55 BW Printer, this machine is compact, measuring only 32 in. wide, 62 in. long, and 48 in. high.

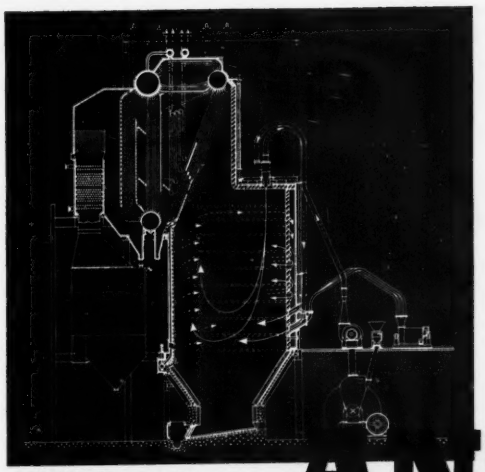
Model 55, a 42 in. printer, operates with either cut sheets or roll stock. It prints ink tracings at from 12 to 15 ft. per min. A full-view speed indicator placed at the center of the front, above the feed board, makes the speed of the machine readily visible to the operator at all times.



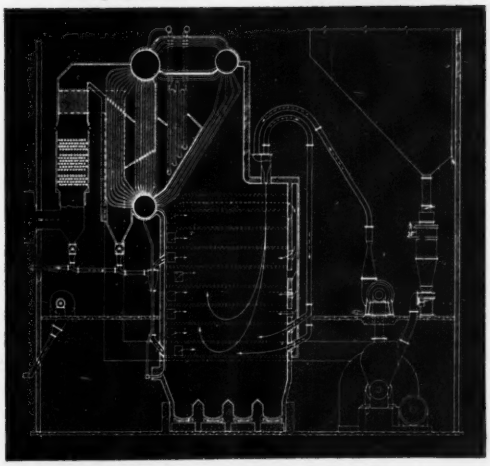
An exclusive feature of this printer is its new print and tracing return. The entire top of the machine serves as a return tray, and the return is so designed that the tracing enters the tray on top of the print, in exactly the same way as it is inserted in the machine. No reversing of the tracing is necessary when reinserting it into the machine. As they emerge from the printer onto the tray, exposed sheets stack themselves almost automatically.

The light source of the new Model 55 Printer is a 55 watt new-type mercury vapor quartz lamp.

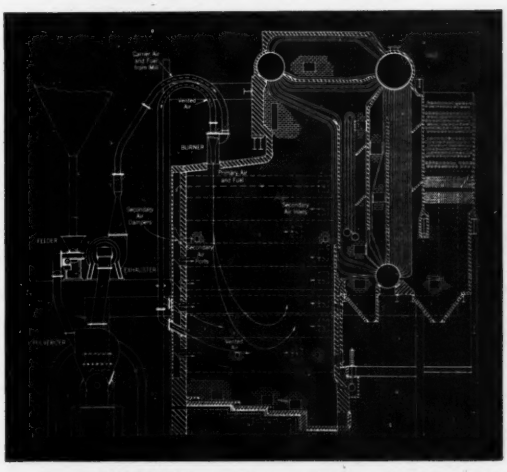
DIRECT FIRING OF PULVERIZED ANTHRACITE



175,000 lb. per hour—Paper Mill



150,000 lb. per hour—Steel Mill



150,000 lb. per hour—Paper Mill

LOW COST FUEL Low cost fuel is available in anthracite—sizes below No. 4 Buckwheat—silt or culm. Early attempts to utilize this waste coal by direct firing were unsuccessful due to high abrasiveness and low volatile. Since 1935, however, highly successful plants have been in regular service.

SPECIAL REQUIREMENTS Ordinary mills could not withstand the abrasion. . . . Special burner and furnace designs were necessary to give long flame travel for complete combustion. . . . Entirely new systems of control were required.

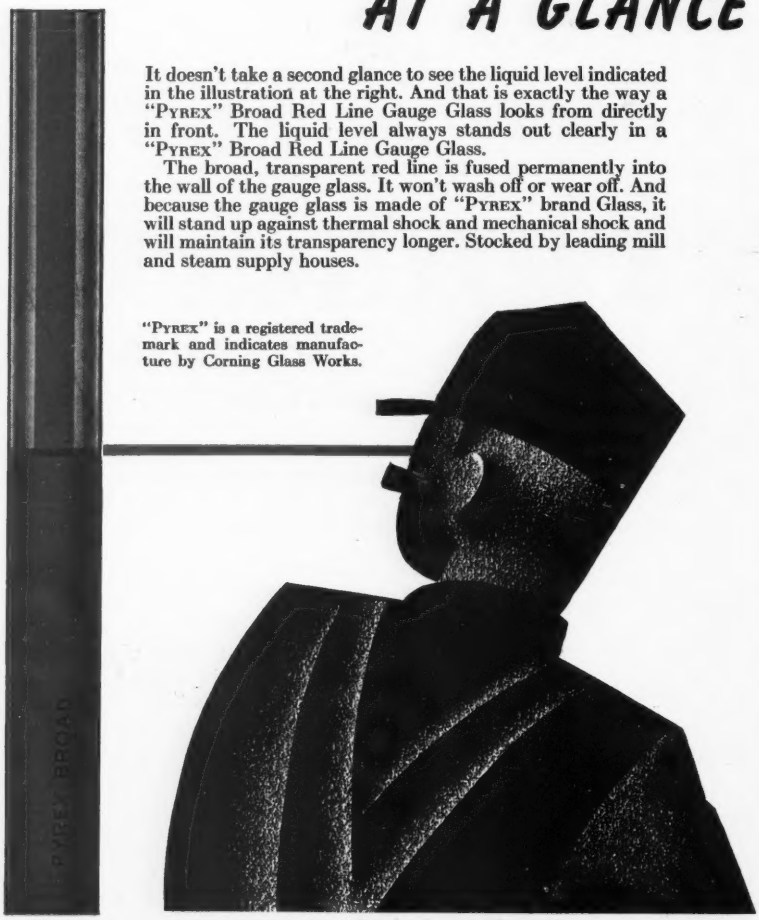
PRESENT STATUS The Foster Wheeler system for direct firing of anthracite has been perfected to a high degree and shows excellent performance and at an exceedingly low fuel cost. Capacities of units now in daily operation vary from 65,000 to 175,000 pounds of steam per hour, with pressures to 725 lb. per square inch. Reliability, simplicity and ease of operation are chief characteristics of the system.

OPPORTUNITY Nearly 30 per cent of the connected horsepower of the country is generated within economic reach of the anthracite slack supply. Each of the applications made has been highly successful, has effected large net savings in the cost of steam production, and is in commercial use alongside of bituminous-fired boilers. Sharp fluctuations in steam load are met with lagless precision.

FOSTER WHEELER CORPORATION
165 BROADWAY NEW YORK, N. Y.

FOSTER WHEELER

Visibility AT A GLANCE



It doesn't take a second glance to see the liquid level indicated in the illustration at the right. And that is exactly the way a "PYREX" Broad Red Line Gauge Glass looks from directly in front. The liquid level always stands out clearly in a "PYREX" Broad Red Line Gauge Glass.

The broad, transparent red line is fused permanently into the wall of the gauge glass. It won't wash off or wear off. And because the gauge glass is made of "PYREX" brand Glass, it will stand up against thermal shock and mechanical shock and will maintain its transparency longer. Stocked by leading mill and steam supply houses.

"PYREX" is a registered trademark and indicates manufacture by Corning Glass Works.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

The Voice of Business

Through their advertisements in POWER PLANT ENGINEERING alert business concerns broadcast to engineers and executives latest news on improved equipment for generating and utilizing power. Reading these messages will help keep you posted on the progress of the field and make more competent buying recommendations.

Pipe Cutter

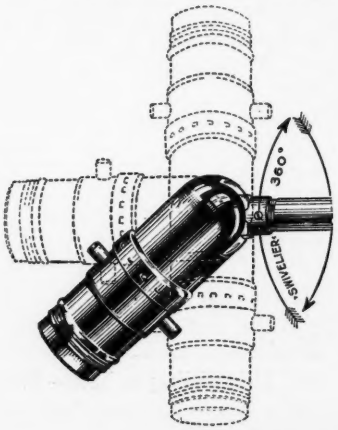
A NEW Ridgid Pipe Tool has recently been announced by The Ridge Tool Co., Elyria, Ohio, a special handle 4-wheel cutter for work in close quarters and

for high cutting speed. The four cutting wheels provide balance and handling under all conditions, cut evenly and save time in cutting iron, steel or brass pipe. Frame is of malleable alloy, capacity ⅛ to 2 in.

Swivel Lamp Socket

A NEW swivel type lamp socket known as the Swivelier has been recently announced by the Reliance Devices Co., New York, N. Y.

Besides being adjustable to a full 90 deg. angle the socket can also be rotated to complete 360 deg. A special stop prevents twisted wires and a powerful



spring compensates for wear due to friction. It is said that machine vibration will not cause the socket to work loose.

The Swivelier can be attached to a rod which, in turn, can be attached to a lathe, drill press, or other piece of machinery.

Glass Cloth

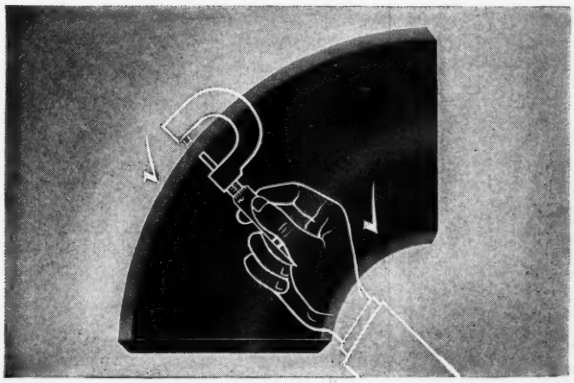
IRVINGTON Varnish & Insulator Co., Irvington, N. J., announces glass cloth available now for use as insulation by manufacturers of electric motors, generators and similar equipment. This new insulation material, known as Irvington Varnished Fiberglas, is furnished in full-width rolls and tape of various widths and thicknesses.

The material consists of a woven glass cloth base impregnated and coated with a special varnish which greatly increases its resistance to abrasion, impact and increases its overall mechanical strength. The resulting material has much higher insulation resistance and much greater ability to withstand heat than other flexible insulations, thus enabling manufacture of lighter, smaller motors for any given horsepower rating and safer operation of these motors under continued overloads.

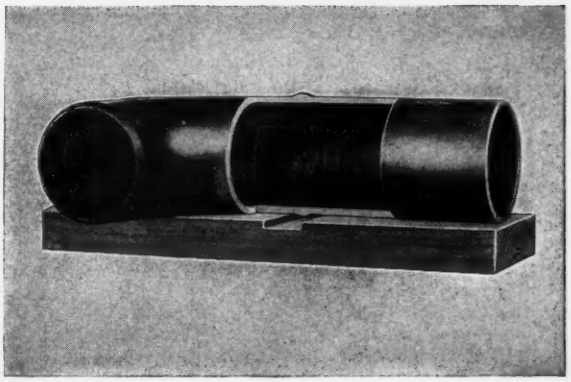
Look at these money-saving reasons

why it pays to insist on

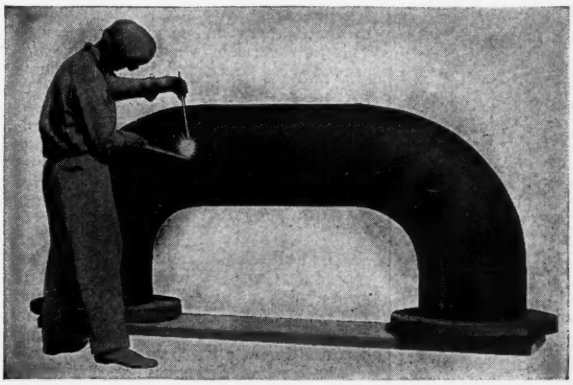
TUBE-TURNS



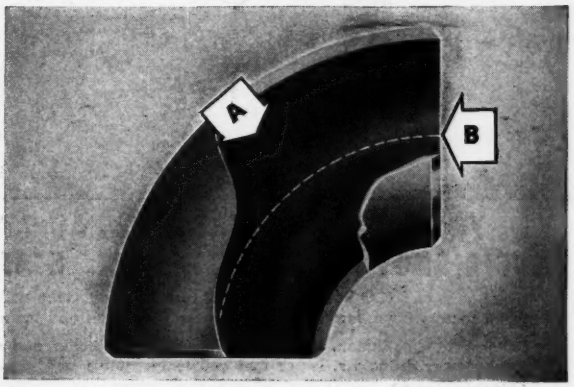
In Tube-Turns seamless welding elbows and returns you get *uniform wall thickness*, within ASTM tolerances, at *all* points —plus improved grain structure with no "locked in" stresses.



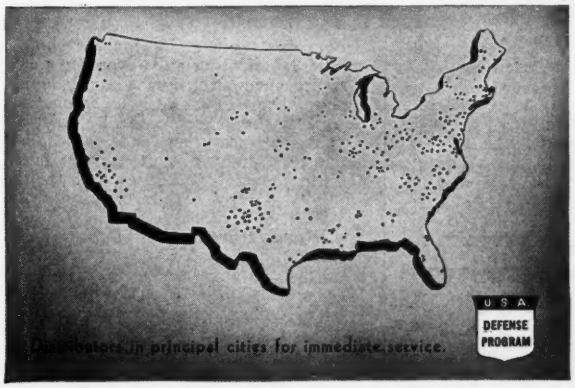
The uniform wall thickness in Tube-Turns permits *exact alignment* with pipe in both O.D. and I.D. (see photo above). This gives you *faster, better* and *more economical welding.*



Tube-Turns are stronger, tighter and lighter. No threads to corrode, no bolts to tighten, no gaskets, no leaks. Tube-Turns cut upkeep expense, are easier to insulate, *yet cost no more.*



(A) Smoother inner walls—with no ridges, waves or scale—mean less corrosion and longer life. (B) Full effective radius insures a *more efficient flow* and *less pressure loss.*



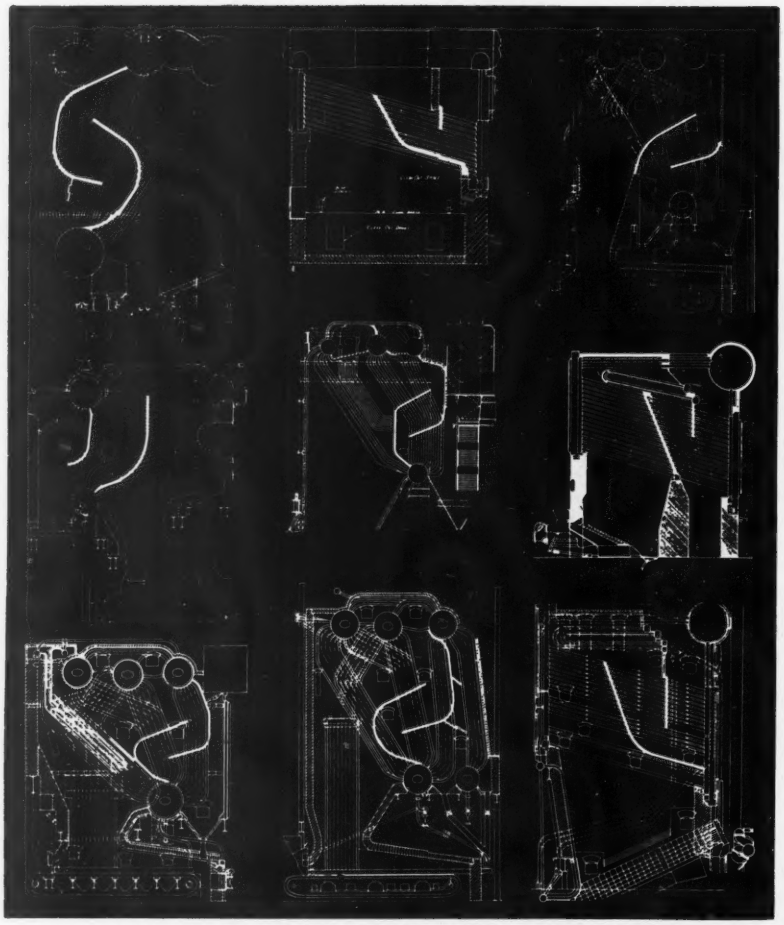
● You'll save money, time and worry by demanding TUBE-TURNS—the *original* seamless welding fittings. You'll get better, quicker service, too. Well stocked distributors in every important city and area—besides ample factory stock—offer immediate delivery. For further facts, or the name of your nearest TUBE-TURNS distributor, get in touch with our closest office shown below!

TUBE-TURNS

90°, 45° and 180° seamless welding fittings, tees, reducers, heads, nipples, laterals, and flanges.

TUBE-TURNS, Inc., LOUISVILLE, KY. • *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Los Angeles

Enco Streamline Baffles



YOU CAN INCREASE CAPACITY AND EFFICIENCY IN EXISTING OR NEW BOILERS

Installation of ENCO Baffle Walls in all types of water tube boilers has resulted in immediate improvement in performance, operation and maintenance.

Better heat distribution, maximum heat transfer to boiler and superheater surfaces, lower draft loss, lower flue gas temperatures and higher capacity are assured through ENCO design and construction. In addition, the smoothly curved surfaces of ENCO streamlined baffles tend to prevent fly ash and cinder accumulation, saving time and steam by making it easier for soot blowers to do a more thorough and efficient job of keeping heating surfaces clean.

ENCO Baffles, constructed gas tight with Enco Plastic, Tile and Reinforcement provide for expansion and assure extra strength. They may be built in desired locations assuring minimum disturbance when tube renewals are required.

Flexible design, the careful selection of materials and their installation by experienced mechanics result in a construction which can be depended on for long service under severe operating conditions.

TAKE ADVANTAGE OF ENCO SERVICE TO IMPROVE YOUR BOILERS

Send blue prints and operating data and ask ENCO engineers to submit suggestions. No obligation, of course. Ask for the new Enco bulletin BW 40—sent FREE on request and containing detailed engineering information on modern ENCO Baffle Walls for all types of water tube boilers. Write for your copy TODAY.

ENCO PATENTED BAFFLES ARE FURNISHED EXCLUSIVELY BY

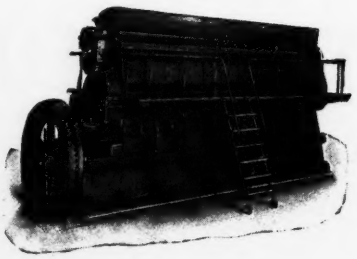
THE ENGINEER COMPANY

75 West St., New York, N. Y.

Diesel Engine

A MODERN Diesel engine incorporating the latest developments in construction, improved design and combustion control has recently been announced by the Chicago Pneumatic Tool Co., New York, N. Y.

Known as CP type 16 Diesel, the engine is of the 4 cycle, direct injection type, especially designed for continuous



duty. Applicable to generator, power and compressor drive, this Diesel may also be converted to a gas engine.

A few of its construction features are, completely enclosed wearing part and an automatic lubrication system.

Insulating Varnish

IRVINGTON Varnish & Insulator Co., Irvington, N. J., announces the formulation of Harvel 612-C insulating varnish, a phenol-formaldehyde synthetic resin-base varnish made from cashew nut shell liquid, which becomes, upon baking, infusible and insoluble. It solidifies throughout, leaving no gummy interiors. This new varnish is stated to have improved speed of cure, flexibility adequate to withstand all internal stresses due to thermal expansion and contraction of windings, resistance to vibration, bonding the conductors into a compact unit-acting mass, and retention of insulating strength at high operating temperatures such as encountered with Fiberglas and other class B insulated windings.

Grid blast coils, made by D. J. Murray Mfg. Co. of Wausau, Wis., are of open design to give free air circulation and avoid dust collection; aluminum and alloy iron are used to make heating surfaces immune to corrosion by atmospheric sulphur compound or moisture; and, as pipe lines and coil chamber are of one type of metal, electrolysis is prevented.

New instruments to be shown at the Southern Textile Exposition, Greenville, S. C., March 31 to April 1 by The Brown Instrument Co., include equipment for indicating and recording temperature, pressure, flow, liquid level, air humidity. Featured is a demonstration of slasher speed control, Moist-o-Graph for measuring and controlling moisture content of cotton yarn, temperature control of kettles and tanks, humidity control for dryers.

Octopus transmission belting of 34-oz. duck impregnated to give grip and resilience is announced by Manheim Mfg. and Belting Co., Manheim, Pa. It is of distinctive green color and is stated to be the outcome of 8 yrs. experimenting to improve pulley grip and resilience.

Fig. 531-P Full Plug Type Bronze Globe Valve
—for severe throttling service of 350 lb. steam

Low maintenance cost

WITH THIS 500 BRINELL FULL PLUG VALVE ON AUXILIARY STEAM LINES • DESIGNED TO HANDLE SEVERE THROTTLING SERVICES

550 Degree Steam at 350 pounds is hard on ordinary bronze valves and particularly so when throttling is constant.

—Seats become wire drawn—Stem threads gall and wear —Bronze bodies distort

THE 531-P IS NO ORDINARY VALVE....SEATS AND DISCS are of Stainless Steel of 500 Brinell Hardness. They will resist wire drawing to the last....**STEMS** are of High Strength Rolled Naval Bronze, highly wear-resistant under the absence of all lubrication....**PRESSURE CONTAINING PARTS** are of the best grade of temperature resisting bronze which can be cast....The valve, with these integrated parts, will take it and give you minimum operating costs which are so important to you today.

READING
CAST STEEL VALVES & FITTINGS

PRATT & CADY
BRASS & IRON VALVES

D'ESTE
VALVE AND ENGINEERING SPECIALTIES

READING-PRATT & CADY

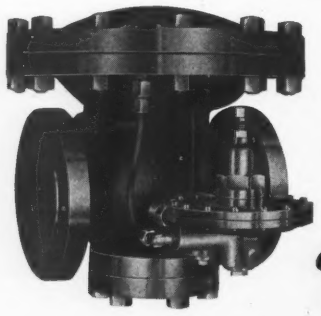
READING, PENNSYLVANIA

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

Manufacturers' News

Edwin L. Dennis

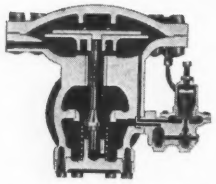
EDWIN L. DENNIS, Chief Combustion Engineer, of Coppus Engineering Corp., Worcester, Mass., since 1939, has been appointed to the faculty of the Louisiana State University, Baton Rouge, La., where he will have headquarters while still retaining his connections with the Corporation. Professor Dennis served in the United States Air Service, 1917-1918, attended L.S.U. and received his B.S. degree, Sugar Engineering, in 1924. Later he was power engineer with The Texas Company; manager, American Syrup Co.; chief engineer and chief of engineering dept., Godchaux Sugars, Inc. Mr. Dennis developed the Coppus-Dennis Fanmix burner which utilizes the kinetic energy of fluid fuels under pressure to maintain constant air-fuel ratios.



OK'ed BY POWER ENGINEERS
For Steam Pressure Control

FISHER Type 92
PILOT OPERATED REDUCING VALVE

. . . Has already won the acceptance of power engineers everywhere. Its remarkable performance records of steam pressure control merits YOUR consideration.



Type 92 sectional view showing cross section of pilot assembly.

ACCURATE

Pilot control—with extreme sensitivity to flow changes—maintains desired reduced pressure with remarkable accuracy. No auxiliary operating medium needed.

COMPACT

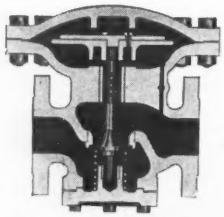
A compact controller with unusually large capacity. Available in 10 sizes from ½" to 2" screwed or 1" to 6" flanged. No special wrenches required for servicing.

FLEXIBLE

Two pilot assemblies for high or low pressure service are available and interchangeable on all Type 92 sizes. Pilot control spring easily adjusted or changed to obtain a variety of reduced pressure ranges.

STURDY

High-tensile bodies and diaphragm casings are extremely rugged, ribbed construction. Inner parts are Duromite bronze or stainless steel—or special material as ordered. Every construction detail designed to assure maximum life.



Type 92 sectional view showing inlet and outlet passages.

Write for Bulletin C1 — gives complete details, prices.

FISHER GOVERNOR COMPANY
• 1001 FISHER BUILDING •
MARSHALLTOWN, IOWA

General Electric Advances W. C. Yates

WILLIAM C. YATES, since 1937 manager of the control and renewal parts division of General Electric's Industrial Department, has been appointed as assistant manager of the Industrial Department, it was announced recently by J. E. N. Hume, manager of the department and commercial vice president of the company. Mr. Yates will continue to have charge of the industrial control and renewal parts division.

Born in Honolulu, Hawaii, in 1878, Mr. Yates attended the public schools of Schenectady, was graduated from the Union Classical Institute with the class of 1894, and received his bachelor of science degree at Union College in 1898.

He then entered the employ of General Electric in the Testing Department, was transferred the following year to the Engineering Department, was appointed engineer in the Rheostat Department in 1904, and in 1908 was sent to the New York Office as industrial control specialist where he remained for five years. In 1913 he returned to Schenectady to become commercial engineer of the Industrial Control Department, being appointed, three years later, manager of Industrial Control Sales. In 1937 Mr. Yates became manager of the control and renewal parts division, in General Electric's Industrial Department, a position he is retaining as part of his new duties.

L. D. Reed

WHITING Corporation of Harvey, Ill., announces opening of a district sales office in Room 838, Broad St. Building, Philadelphia, Pa., to cover eastern Pa., southern N. J., Del. and Md. The office will be in charge of L. D. Reed who has been with the Whiting Corp. for 26 yr. as engineer and salesman.

F. M. Gardner

F. M. GARDNER has become associated with The Cooper-Bessemer Corp. of Mt. Vernon, Ohio, to further sales of Diesel and gas engines to power plants.

Starting at 16 years of age with Fairbanks, Morse & Co. in its Beloit plant, Mr. Gardner advanced through shop, test floor and erection departments to engineering sales, first at Cincinnati and later as manager of the machinery department at Cleveland.

After 25 years with Fairbanks, Morse & Co., he became sales manager of Anderson Engine & Foundry Co. for 6 years, then accepted the position of sales

"WHEN WE BUILD..WE'LL BUILD FOR MODERN COAL"

..said 90% of municipal power plant managements building new plants in '39 and '40!

OF THE NEW municipal power plants built during the past two years to operate on a single type of fuel, COAL was chosen by a margin of *nine to one!*

For cities or private industries, large or small, the source of power must be *dependable*. Shut-downs are costly at any time, but in a nation geared to a huge defense job they're doubly serious. Industry knows it can rely on modern prepared coal for the steady production of steam power and a quick response to extra load demands. Furthermore, utility and industrial figures underscore the *economy* of modern coal—in terms of lower cost per pound of steam, higher plant efficiency and lower maintenance costs.

WHAT'S YOUR POWER PROBLEM?

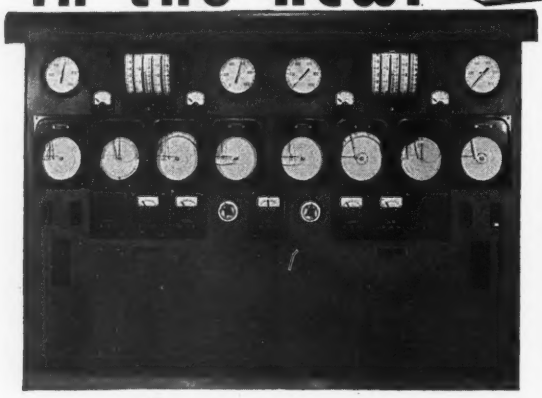
In many power plants the free assistance of Chesapeake and Ohio Fuel Service Engineers has proved invaluable. If you have a problem involving fuel costs and efficiencies, these highly skilled men may find the answer for you. Why not let them study your present set-up, confer with your engineers and make suggestions? You have everything to gain—without cost or obligation. If you'd like us to send one of our engineers, write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2903 Terminal Tower, Cleveland, Ohio.

IT PAY$ TO U$E MODERN...

Chesapeake and Ohio Lines

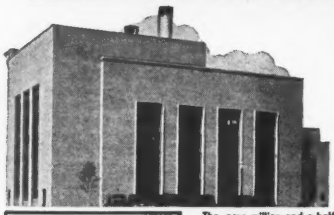
OK IN THE OLD PLANT

HAYS Repeats in the NEW!



HAYS *Automatic* COMBUSTION CONTROL...

was so satisfactory in the old municipal light plant at Holland, Michigan, that it was chosen for the new million-and-a-half dollar plant now serving this thriving little city.



The new million-and-a-half dollar municipal light plant at Holland, Michigan, one of the most modern and efficient in the U. S. A.

THE practicability of automatic control of combustion in the operation of a steam generating plant is strikingly demonstrated in this model light plant. Two identical sets of equipment, each consisting of a steam generating unit and a 7500 kw. turbine generator, with all their associated auxiliaries, may be operated singly (usually alternating) or together. It is designed for 550 lbs. gage pressure and 825° F. total temperature. The load varies widely but even at its lightest the CO_2 percentage is maintained at 15% with as high as 17% CO_2 at high load. Steam pressure remains constant. Another case proving the value of Hays Automatic Combustion Control in securing test operating efficiency every minute of the day and night! Write for full particulars.

Engineers please note:

Tear off the bottom of this ad and send with your name and address to The Hays Corporation and we will send you copy of "Automatic Combustion Control and Its Relation to Lower Steam Costs."

THE HAYS CORPORATION

SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A.

The Indispensable Tool

During the last sixty years the use of mechanical power in industry has increased more than fourfold per worker and the output per worker has increased more than fivefold. A large part of this progress has been due to the use of advertising as a means of telling industry about the improved ways of generating and utilizing power. The machine age means better equipment for more plants and workers, and advertising is its indispensable tool.

manager with Bell-Muncie Co. of Muncie, Ind., also assisting in engineering design. Later he acted as sales representative for Ideal Electric & Manufacturing Co. and for National Supply Co.

Mr. Gardner will cover Western Ohio, Indiana, Kentucky and Tennessee for the Cooper-Bessemer Corp.

W. D. Preston

W. D. PRESTON of the Steel Boiler Division of the Oil City Tank and Boiler Co., Oil City, Pa., has been appointed assistant to the Vice President in charge of sales, and will be in charge of the 70 sales offices, also will act as special government agent for the Company.

Due to increased activity in all divisions of Manning, Maxwell & Moore, Inc., several changes and additions to its personnel covering the sales organization have been announced.

T. J. Naughton, formerly of the Chicago office, has been transferred to Minneapolis to cover the states of Minnesota and North Dakota, and portions of South Dakota, Iowa and Wisconsin.

E. C. Robinet, formerly in the Los Angeles office, has been transferred to the Pacific Northwest territory, located at Seattle, Washington.

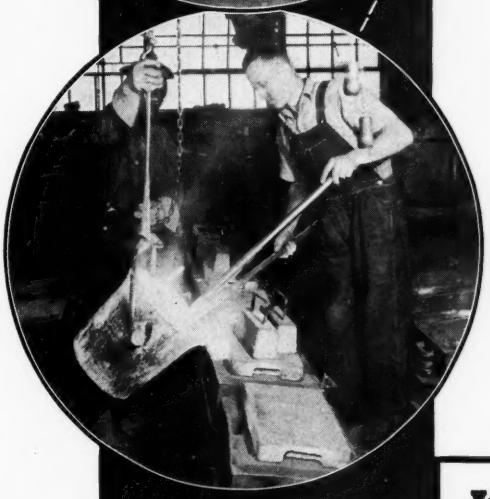
J. E. Day has joined the organization as representative in the Charlotte, North Carolina, district.

W. F. Williams has joined the organization to work with the accounts in the oil industry out of the Chicago office.

Charles Stepan, for the past several years working in the Chicago district, has been promoted to the newly created position for the handling of sales of Consolidated House Heater Boiler Pop Safety Valves, House Heater Boiler Gages, Ashcroft Hevi-Duti and Streamlined Gages for equipment manufacturers. Joseph A. O'Connor, recently with the Hartley Gauge Co., will assist Mr. Stepan in the handling of sales.

W. H. & L. D. Betz of Philadelphia announce the opening of new district offices: in St. Louis at 455 Brown Bldg.; in Cincinnati at 831 Temple Bar Bldg.; in Montreal at 2009 Royal Bank Bldg.; in Toronto at 1207 New Wellington Bldg. Additional representatives appointed are: W. A. Krebs, M.E., Greensboro, N. C.; Francis Marksson, M.E., Savannah, Ga.; Albert E. Hall, B.S., Birmingham, Ala.; H. T. Campion, San. Eng., Grand Rapids, Mich.

Okonite Co. of Passaic, N. J., has opened an office in 1212 Comer Bldg., Birmingham, Ala., with Dewey A. White in charge. He will cover Tenn., Ala., Miss. and La., No. and So. Car.; Ga. and Fla. remaining in charge of George N. Brown, manager of the Atlanta office. St. Louis office has moved to 1406 Shell Bldg., Robert E. Sontag remaining as manager.



There's more to POWELL QUALITY than meets the BUYER'S EYE!

...LET'S TAKE SMALL VALVE MANUFACTURE...

In Core Making, Metal Melting and Pouring, the Exact, Scientific Procedure Used in Checking Powell Designs and Metals Is Followed.

The production of ever better valves starts in Powell laboratories, where trained engineers and metallurgists constantly check and change designs . . . accurately test all the metals and alloys that go into Powell products . . . and this scientific proving procedure **prior** to manufacture **is carried through the actual building of the valves** . . . from painstaking skill in making perfect cores, to the strenuous tests required to assure valve satisfaction.

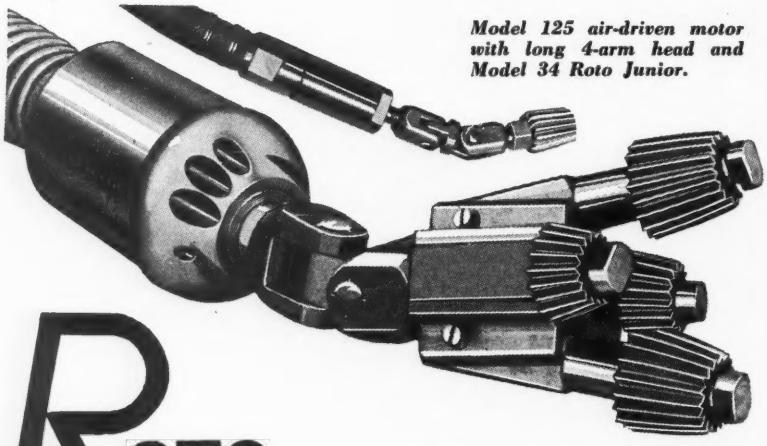
First, delicate, sensitive fingers handle the fine work of making cores for Powell small valves . . . to assure perfect models from which to make perfect valves. Then, in the foundry, each batch of molten metal is carefully tested for its specific job. Third, pouring . . . utmost care is taken to avoid porosity and sand or slag inclusions . . . every single pouring is under the direct supervision of a specially trained craftsman.

There, in a picture, is one phase of modern valve manufacture . . . next month, we'll complete the small valve cycle . . . show where and how the other, more advanced operations are constantly checked to guarantee **"quality, through and through"**. Consider this when purchasing your next order of valves . . . specify Powell for value and performance.

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer.

POWELL VALVES

THE WM. POWELL COMPANY • CINCINNATI, OHIO



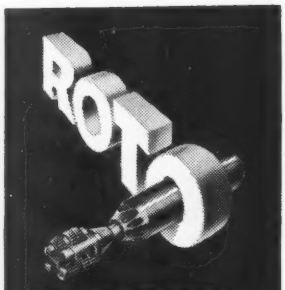
Model 125 air-driven motor with long 4-arm head and Model 34 Roto Junior.

ROTO

The Correct Prescription for Tube Scale

Chemistry and constant vigilance work wonders in keeping down the amount of scale deposited in modern tubular equipment. But, sooner or later, mechanical tube cleaning becomes inevitable. The equipment manufacturer, vitally interested in its performance, is naturally anxious to select the very best cleaner for the job.

It is a tribute to the rugged dependability and effectiveness of the new Roto Tube Cleaners that so many leading equipment manufacturers now supply them as original equipment. Roto carefully checks each individual requirement to make sure that the cleaner prescribed will give satisfactory service. Roto offers time and labor saving features found in no other tube cleaners. It will pay to get full details.



Send for our illustrated bulletin describing various types and sizes of Roto Tube Cleaners for Power Plants.

Write for Power Plant Tube Cleaner Bulletin

The ROTO Company

145 Sussex Avenue · NEWARK, N. J.

Reliable Buying Bulletins

In these pages you will find advertisements of firms that make every type of machinery and equipment for generating, distributing and utilizing power. Their messages constantly record latest progress in power plant equipment. They tell you who makes it, who stands behind it. Consider their advertisements as convenient and reliable buying bulletins.

Fulfilling a long-time desire, Henry M. Hale, eastern sales manager of Caterpillar Tractor Co., has resigned to become an independent merchant of Caterpillar products in partnership with John R. Taylor, as the Taylor-Hale Machinery Co. at Memphis, Tennessee, to handle Caterpillar sales and service in an extensive southern area. George Rinck has been advanced from assistant eastern sales manager to succeed Mr. Hale, and Kenneth Cox will be the new assistant eastern sales manager.

M. P. Robinson, proprietor of the Robinson Filter Co. has joined the Worthington Pump and Machinery Corp. organization to take charge of its newly organized water purification equipment division. Prior to the establishment of his own water purification company in 1937 Mr. Robinson had, for 17 yr., been eastern representative of the International Filter Co. of Chicago.

Appointments are announced by General Electric Co. of F. E. Fairman, Jr., as assistant manager of switchgear division, Central Station Dept., Philadelphia, Pa., and J. D. Hoffman as manager of sales of the equipment section in the same division, to take over former work of Mr. Fairman. Mr. Fairman has been with G. E. Co. since 1923, for the most part on switchgear work and Mr. Hoffman since 1922.

A. A. Dahms has been made manager of the Davenport, Iowa, branch office of Allis-Chalmers Mfg. Co. Prior to his recent appointment, he was for many years connected with the company's Chicago office. He will be assisted in his new work by E. A. Rensch and C. J. Schutty.

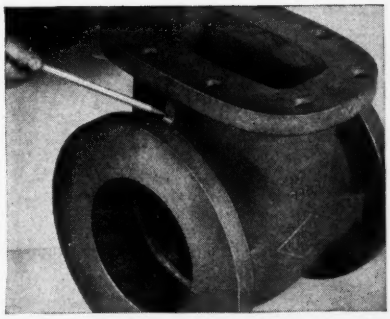
H. F. Schotters has been appointed to supervise the distribution of Hobart Arc Welders in northern Indiana and western Michigan, with headquarters at Koontz-Wagner Electric Co., South Bend, Indiana.

National Aluminate Corp., Chicago, Ill., announces appointment as Junior Salesmen of: F. J. Barnett and B. J. Lamb in the Texas territory under E. F. Fellows; C. J. Van Riper under R. G. Stewart with headquarters at Knoxville, Tenn.; R. W. Cover in the Pittsburgh, Pa., area under H. R. Powers.

Appointment of new representatives of Plandaire, Inc., Pittsburgh, Pa., has been recently announced by Lee Eils, vice-president.

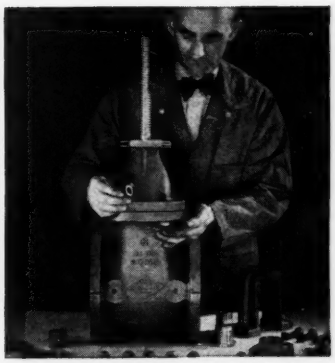
W. A. Witheridge Co., Saginaw, Mich., for northeastern Michigan; John Lloyd & Sons, Allentown, Pa., for northeastern Pennsylvania; Hero D. Bratt, N. W., Grand Rapids, Mich., for western Michigan; Harry E. Clark, Houston, Tex., for eastern Texas; Karl J. Hart, Jackson, Miss., for Mississippi; A. L. Haskins, Rochester, N. Y., for that territory; Electrol of Iowa, Des Moines, for that state; Percy L. Luck, New Orleans, for southeastern Louisiana; George W. Stetson, Boston, for eastern Massachusetts.

Committee of Ten, Chicago, Ill., reports sales of coal-burning stokers for 1940 of 151,905 units, an increase of 45.7 per cent over 1939, as shown by the Bureau of Census. Of the total, 135,084 machines, or 89 per cent were for residence and small commercial heating units.



1 Look at that heavy reinforcing rib—just one of many extra strength features you get in this liberally proportioned, semi steel body—average tensile strength 35,000 per sq. in.—which has six blind bosses for by-passes and drains.

2 Now note the *depth* and generous proportions of this bonnet—to allow the wedge to lift entirely out of the line of flow.

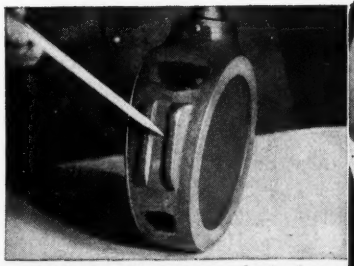


3 Eight of these sturdy *through bolts* on our 6" valve make it an easy job to remove the bonnet for maintenance or cleaning. No trouble with broken or corroded studs.

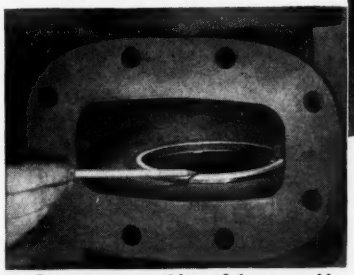
Don't Guess —

look inside this Iron Gate before you buy!

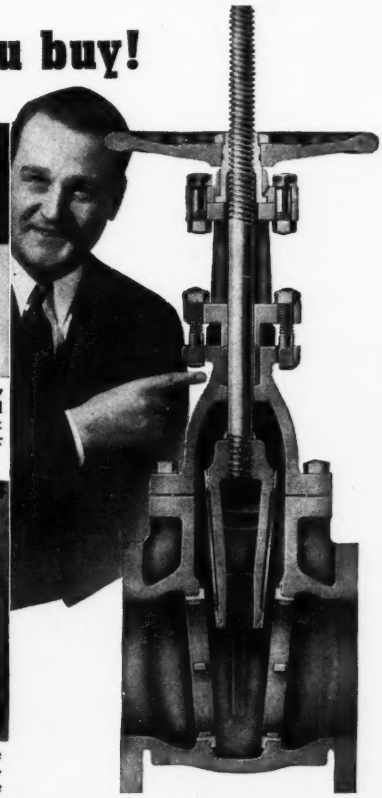
4 See this substantial Yoke—deep enough to prevent spindle threads from entering the packing chamber when wedge is completely lowered.



5 Notice that this cast iron wedge has heavy bronze face rings—*rolled in*, then machined to gauge. Also—deep guide channels that insure alignment and minimize chatter when valve is partly open.



6 Put a gauge on either of the renewable bronze seat rings to check the watch-movement precision with which they are made—and screwed into body in all sizes.



Improvements in Gate Valve design have created many differences that you should know about . . . Check over the features of this O. S. & Y.—I.B.B.M. Gate—JENKINS FIG. 651.

It will pay you to get the facts about Jenkins Iron Body Gate Valves. Compare the improved design, construction and convenience features shown in the photos. Then consult the clear-cut section view that shows how Jenkins gives you *reserve* strength at every possible point.

For example—the extra length spindle with deep, liberal threading—of correct pitch and lead for a practical balance between speed and ease of operation. Notice the husky bronze yoke sleeve with a maximum of threads engaging the spindle—for longer, trouble-free service. Also, the heavy cast iron packing gland—and many other features to which no photos would do justice.

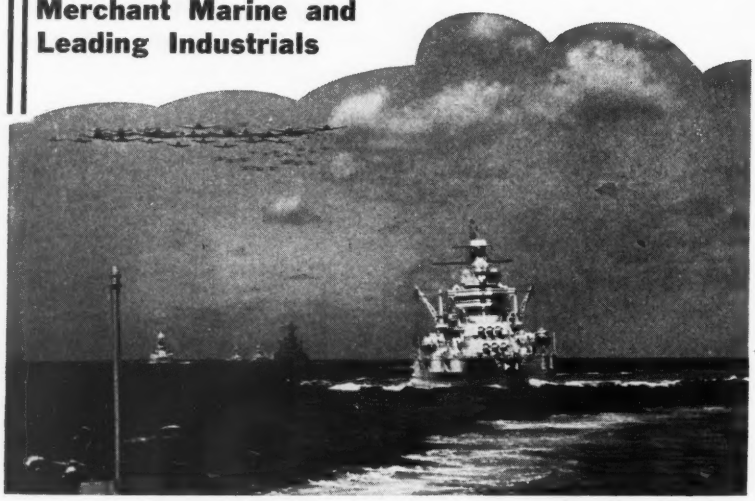
So why not inspect the valve itself. See why Jenkins means *top-quality*. Yet they *cost no more*. Prompt delivery from stock at reliable supply houses everywhere.

JENKINS BROS., BRIDGEPORT, CONN.

LOOK TO Jenkins FOR THE BEST IN VALVE DESIGN

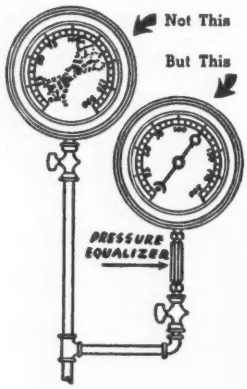
NATIONAL Gauge Pressure Equalizer

Used for several years by the
UNITED STATES NAVY, Merchant Marine and Leading Industrials



Protects Your Gauges and Recording Instruments from Hammer and Damage Caused by Surging, Pulsating Pressures

Act as Pulsation Dampeners— Your Instruments tell the truth



1. Increases life of instrument.
2. Two parts its entire construction.
3. No change or adjustment ever needed.
4. Same Equalizer used on 5 p. s. i. or on 50,000 p. s. i. pressures.
5. Can be transferred to any service needed without injury.
6. NO VALVE STEMS TO BEND.
7. NO DIAPHRAGMS TO REPLACE.
8. NO WORN OUT RUBBER SACS.
9. WILL NOT CLOG. LAST INDEFINITELY.
10. Its merit recognized by leading instrument and gauge manufacturers.
11. MADE FOR ALL CONDITIONS AND PRESSURES.

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ENGINEERING PRODUCTS
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Let Us Know About It

If you have a problem on the installation or operation of power equipment, or if we can be helpful in securing latest catalogs or information from manufacturers, let us know about it. There is no charge for this service. Write Reader Service Department, POWER PLANT ENGINEERING.

Tom H. Pike, Jr., west coast district manager for Tube-Turns, Inc., Louisville, Ky., has established offices in Los Angeles at 210 W. 7th St., to serve the west coast and territory inland as far as Salt Lake City. Also, John C. Chaffe has been appointed district manager of the company's Philadelphia office in the Lafayette Building, to cover area that extends through Wilmington, Baltimore, and Washington, D. C.

Important changes are reported in engineering staff of the Bureau of Reclamation. Irving C. Harris, director of power at Boulder Dam, will become Senior Engineer in charge of installation of heavy power machinery at Shasta Dam of Central Valley (Cal.) project.

E. A. Moritz, construction engineer of Marshall Ford (Tex.) Dam, will take Mr. Harris' place at Boulder Dam, being succeeded by Charles P. Seger.

Samuel A. McWilliams, resident engineer at Minidoka (Idaho) plant will go to Parker Dam as construction engineer in place of Edward C. Keppen, deceased.

The Seamless Steel Tube Institute, Pittsburgh, Pa., announces the adoption of a program of market reasearch and related activities which is to be put into effect March 1st, 1941, under the direction of W. A. Cather, now advertising manager of The Babcock & Wilcox Co., New York City.

In his new position, Mr. Cather will operate out of the Institute's office in Pittsburgh and the offices of the Michel-Cather organization, New York City.

Island Creek Coal Sales Co. announces through H. A. Glover, vice-president in charge of sales, several changes in its sales staff.

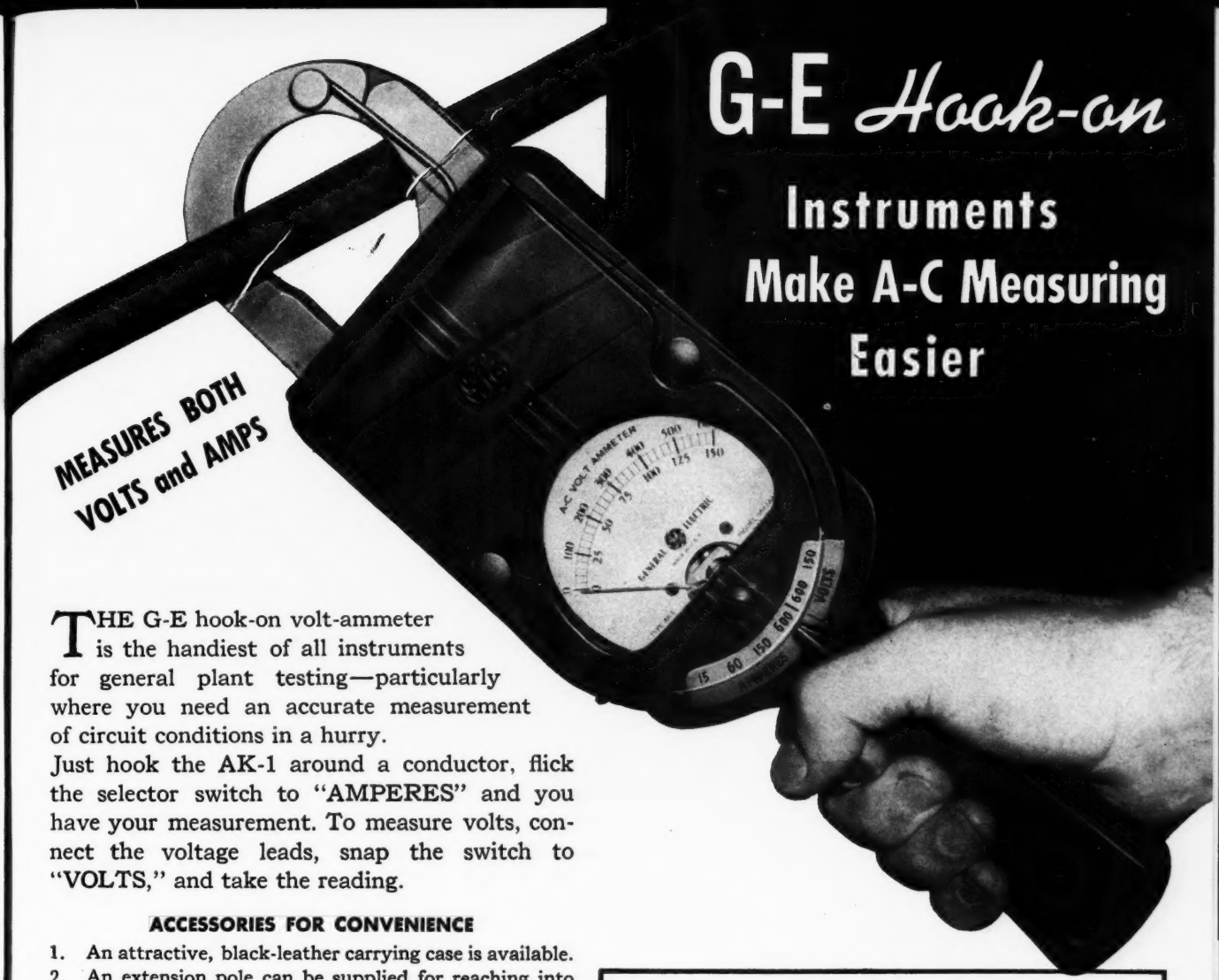
C. R. Mabley, Jr., becomes assistant to the vice-president, in charge of sales promotion, with headquarters at Huntington, W. Va. E. G. Steinwart is now assistant manager of sales at Cincinnati, Ohio. H. B. Mondey will serve as sales manager for Appalachian Coals, Inc., Mallory Coal Co., and Princess Elkhorn Coal Co., with headquarters at Huntington. T. A. Day is made special representative on sales to retail coal dealers and public relations.

Harry A. Burdorf and Frank P. Rhame, vice-presidents of the Lunkenheimer Co., Cincinnati, Ohio, were elected to the board of directors at the recent annual stockholders meeting.

Burdorf, who has been with the company since 1905, is vice-president in charge of sales, and Rhame, who has been with Lunkenheimer since 1919, is vice-president in charge of sales engineering.

Midwest Stoker Association at its annual meeting elected as officers for 1941: Mount Burns, manager, Chicago Retail Stoker Division of the Link-Belt Co., president; E. M. May, Chicago branch manager of the Combustioneer Division of Steel Products Engineering Co., vice-president; E. W. Jones, Chicago office manager for Iron Fireman Mfg. Co., secretary-treasurer. Marc G. Bluth was reappointed manager of the Association.

G-E *Hook-on* Instruments Make A-C Measuring Easier



THE G-E hook-on volt-ammeter is the handiest of all instruments for general plant testing—particularly where you need an accurate measurement of circuit conditions in a hurry.

Just hook the AK-1 around a conductor, flick the selector switch to "AMPERES" and you have your measurement. To measure volts, connect the voltage leads, snap the switch to "VOLTS," and take the reading.

ACCESSORIES FOR CONVENIENCE

1. An attractive, black-leather carrying case is available.
2. An extension pole can be supplied for reaching into inaccessible places and for additional protection on high-voltage circuits.
3. Voltage leads are included with each instrument.

AND A LOW-COST HOOK-ON RECORDER FOR CONTINUOUS RECORDS

For trouble investigations and maintenance—where a permanent record of a-c circuits is needed—this G-E hook-on current-measuring set is ideal. It consists of a Type CF-1 recording ammeter and a split-core current transformer.

IT'S INKLESS—ready to go at a moment's notice—no inkwell to fill, no pen to start, and no ink to spill and blur the record.

The set is simple to use—just connect the CF-1, close the jaws of the transformer around a conductor, and it starts to record. The instrument operates without attention and has a 30-day chart length. Timing of the chart drive is accurately controlled by a Telechron motor.

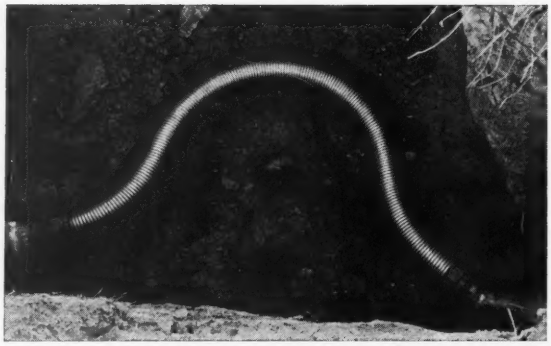
Type CF-1 inkless recording voltmeters are also available.

For further information on the hook-on voltammeter, ask for Bulletin GEA-2950; on the recorder, GEA-3187. Your G-E office has copies, or write to General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

602-20

Courtesy of
Aronimink Park Heating Co.
Drexel Hill, Pa.



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Tight as pipe, but flexible

Inexpensive underground expansion unit

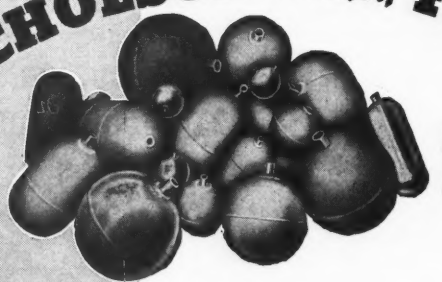
Bronze or Steel
Sizes to 16"

Buried right in the earth, without covering of any kind, 6 ft. lengths of 3" galv. steel tube afford all of the "come and go" needed for steam at 25 to 35 lbs. used in central plant heating. How come? There's ⅜" of "come and go" in every foot of PENFLEX 4-wall interlocking joint design. With no slip-joints to be repacked, no manholes are needed. Savings? . . . Wonderful! Try PENFLEX.

Get the many good ideas in Bulletins 52 and 59

Pennsylvania Flexible Metallic Tubing Co.
7207 Powers Lane, Philadelphia, Pa.

NICHOLSON *Welded* FLOATS



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Other NICHOLSON Products:
Industrial Steam Traps
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Control Valves
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Flexible Couplings
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Steam Eliminators and Separators
•
Compressed Air Traps

For High Pressure Service

One of the surest ways to end float troubles in high pressure steam and hydraulic service is to install Nicholson Welded Floats.

These modern floats are die-formed (not spun or laminated), with the welding seam serving as a reinforcing ring. This extra sturdy construction enables Nicholson Welded Floats to stand hydrostatic pressures up to 2500 lb.

Available in special, cylindrical and elliptical shapes in sizes from 2 to 14 in. diameter in stainless and chromium plated steel. Fully described in Bulletin 339.

W. H. NICHOLSON & COMPANY
160 OREGON ST. WILKES-BARRE, PA.

Stone and Webster Engineering Corp. has announced that James A. Powell, of Reading, Pa., will become associated with that organization on March 1st and will have his headquarters office at 49 Federal Street, Boston, Mass. Mr. Powell is well known in engineering circles and for many years he has been associated with the E. M. Gilbert Engineering Corporation from which he recently resigned as vice-president and chief engineer.

Since F. L. Wilsell of Toledo, Ohio, who has been president of National District Heating Association, has become president and general manager of Pueblo (Colo.) Gas and Fuel Co., he has found it necessary to resign the presidency of N.D.H.A. and Leonard S. Phillips of N. Y. Steam Corp., first vice-president, becomes president. John M. Arthur, Jr., of Kansas City (Mo.) Power and Light Co. becomes first vice-president and Raymond M. Nee of Boston (Mass.) Edison Co. second vice-president.

John W. Clarke Co., Chicago, Ill., has been appointed representative of Roller-Smith Co. for the Chicago territory, succeeding E. E. Van Cleef, recently deceased. Announcement is made by W. R. Swoish, sales manager of the Roller-Smith Co., who also states that M. B. Mathley will be associated in the sales staff of the office, and C. Swain Lumley as district engineer.

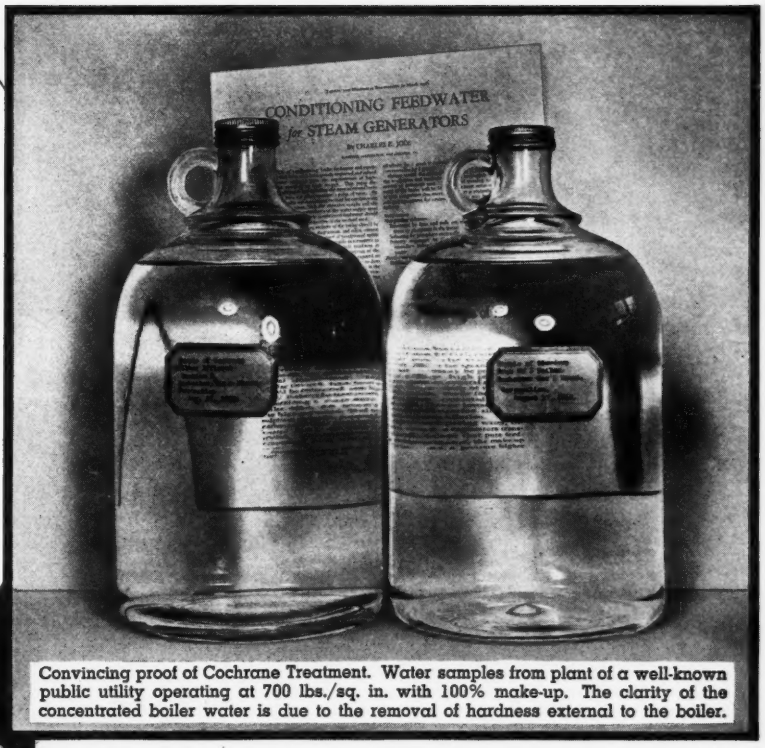
Clinton E. Swift has become associated with the Weldrod Division of Ampco Metal, Inc., Milwaukee, Wisconsin, to head the development, production, and distribution of Ampco-Trode. Since graduating from the University of Illinois, Mr. Swift has been associated with the welding industry with such companies as Westinghouse Elec. & Mfg. Co., American Brass Co., C. F. Braun & Co., and the Young Radiator Co.

New high voltage testing laboratory is to be built at Cornell University for 60-cycle and impulse work, with capacity of 750,000 v. single-phase and 433,000 v. 3 phase, and able to simulate lighting discharge at 3,000,000 v. It will be used for investigating properties of air and insulating materials, corona phenomena, and for commercial testing of insulators, switch gear and transformers. It will be in charge of Dr. Eric T. B. Gross, former head of A.E.G. in Vienna, who will be a lecturer in the School of Electrical Engineering and serve as Westinghouse Research Associate.

Tests have shown that for locations where wet contacts are possible, such as internal cleaning and repairs on boilers and tanks, any voltage over 12 v. may be dangerous. To remove the hazard of use of 110 v. lamps in such locations, Public Service Electric & Gas Co. of New Jersey has adopted a system of 6 v. lamps with standard bases and sockets, supplied by 110/6 v. transformers. The cords and connections have usual insulation for 110 v. waterproof lines. The transformers weigh about 5 lb. with metal casing, with only the leads projecting beyond the casing. Lamp cord can be easily replaced. The transformer is moisture resistant, but not closed against submersion in water. It has high insula-

The VERSATILITY *of the* COCHRANE *Hot Process* SOFTENER

makes it adaptable to practically any condition of boiler feedwater...



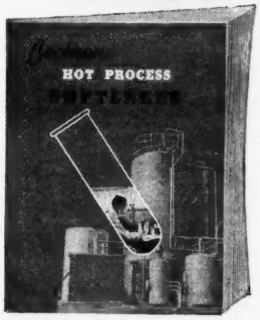
Convincing proof of Cochrane Treatment. Water samples from plant of a well-known public utility operating at 700 lbs./sq. in. with 100% make-up. The clarity of the concentrated boiler water is due to the removal of hardness external to the boiler.

THE conditioning of the boiler feedwater of the modern high-pressure steam generator is no longer the rather simple problem of ten or twenty years ago. The softening process in particular requires careful study and detailed specification.

For the majority of feedwater problems, the Cochrane Hot Process Softener offers the most flexible solution. The engineer has a wide range of treatments from which to select, depending upon the chemical character of the water.

The most commonly used reagents are lime and soda ash, but for special conditions, such as silica removal or other forms of hardness, a wide range of additional reagents are available, without necessitating alteration in the equipment itself.

The Cochrane Deaerating Hot Process Softener is the ideal feedwater conditioning equipment, combining in one piece of equipment the versatility of the Hot Process Softener together with complete deaeration. Write for a copy of "Cochrane Hot Process Softeners."



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Please send me a copy of your publication, "Cochrane Hot Process Softeners."

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WE READ WATER

Every drop of water and every drop of brine has a story to tell us. We know how to read it and answer the many difficulties it is bringing your plant. The story tells a battle against efficiency in your plant . . . corrosion, scaling, living organisms, too much of this chemical, too little of that. We read it, tell the answer, and have the organic chemicals to correct the water and the brine. Known throughout the Nation are these Haering products . . .

Chrom Glucosates
For Corrosion Prevention

Sodium Glucosate
For pH Adjustment

Sulpho Glucosates
For Oxygen Removal

Quachrom Glucosate
For Corrosion Control

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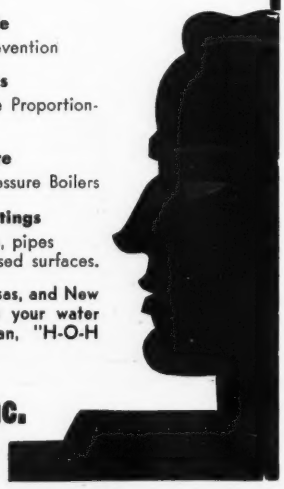
For Scale Prevention

H-O-H Feeders
For Accurate Proportioning

Pyro Glucosate
For High Pressure Boilers

In-Hib-Co Coatings
Protect tanks, pipes and all exposed surfaces.



Our laboratories in Chicago, Wichita, Kansas, and New York City serve you overnight. Send us your water problems; or write for our house organ, "H-O-H LIGHTHOUSE."

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Water and Brine Consultants

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DESIGNERS AND ENGINEERS

Squad leaders, checkers, designers, computers for design of 350,000 ton annual capacity steel plant.

PLANT LAYOUT:
Experienced in any one or more of the following: boiler or power house; blast furnace blowing equipment; steel plant pumping stations; rolling mill equipment such as motor rooms storage yards; rolling mill auxiliaries for blooming; hot strip, cold sheet universal plate and tin mills; rail and structural accessories. General plant shops such as machine, electrical, pattern, forge, etc., also general steel mill buildings such as office, laboratories, etc., and transportation and sewer systems.

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Experienced in any one or more of the following: general steel mill buildings, intricate reinforced concrete structures such as machinery and building foundations, steel and concrete trestles, etc.

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Experienced in any one or more of the following; general steel plant piping such as water, steam, air systems for rolling mills, power house, pumping stations, etc.

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Experienced in any one or more of the following: general power plant such as overhead and underground distribution systems, switchboards, lighting, etc.

TECHNICAL ASSISTANTS:
Experienced in general computation such as calculating distribution of utilities and materials, determination of flow diagrams for power, fuel, water, compressed air, steam, etc. Preparation of specifications and economic study of steel plant equipment and operation.

IN REPLYING:
Give full particulars in first letter, qualifications, past experience in detail and date available. Write to:

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Attention—Stephen A. Derry, Personnel Director

tion between 110 v. and 6 v. windings, is dried under vacuum and treated with moisture-proof varnish, and must show insulation resistance safe against 2500 v. for 1 min. The transformer is cylindrical with hemispherical ends, 9 in. long by 3 in. diam. with 110 v. leads from one end and 6 v. leads from the other.

In steam turbines made for Morse Steam Turbine Division, Worthington Pump & Machinery Co., Wellsville, N. Y., by Johnston & Jennings Co., Cleveland, Ohio, rotor and shaft are forged integral from nickel-chromium-molybdenum steel, SAE 4340 to avoid loosening of rotor from shaft. Arduous conditions, steam at 900 deg. F. and bringing from a cold start to full speed in a few seconds, make this construction and material desirable. Weight of the piece rough turned is 745 lb., the shaft being 61½ in. long and rotor diameter $27\frac{7}{16}$ in.

Scholarships are available at Cornell University for 50 high school seniors, to be chosen for character and general ability, to undertake courses in Civil, Electrical or Mechanical Engineering. Each scholarship will carry $400 a year for 4 or 5 yr., from the John McMillan Fund. Awards will be distributed over 15 districts outside New York State.

In addition, 15 graduate scholarships for one year, each carrying $900 are available from the same fund; a one year scholarship for $510 in hydraulics from the Elon Hooker Fell Fund; and a $400 scholarship in Electrical Engineering from the Charles B. Earle Fund.

Application should be made to Dean S. E. Hollister, Cornell University, Ithaca, N. Y.

In order to keep pace with the increased demand for products of its manufacture, Manning, Maxwell & Moore, Inc., Bridgeport, Connecticut, announces that a sixth floor has just been added, and about 50,000 sq. ft. of space leased across the street. While the Hancock Valve Division, whose plant is located in Boston, has secured an additional four-story factory to be devoted exclusively to the manufacture of its valves.

For quickly supplying or restoring power to defense or other industries in case of emergency, mobile substations are now under construction by General Electric Co., the first being delivered to Central N. Y. Power Corp. of Syracuse. It is mounted on a special trailer chassis and can be hauled at 40 mi. per hr. Dimensions are 11 ft. 6 in. high (reducible to 9 ft. 10 in. for low clearances), 21 ft. long, 8 ft. wide, weight 10 t. Equipment is a 3 phase, 1000 kv-a. transformer with primary and secondary switching and lightning arresters, to take power from lines of 11,000, 13,200, 22,000, 33,000 or 44,000 v. and deliver at 230, 460, 2300, 4000 or 4600 v. Putting into service consists of parking and grounding the unit and making connections to primary and secondary lines.

Three more substations are under construction at Pittsfield, Mass., works, stations up to 3000 kv-a. being possible to transport within most road limits.

Insulation Facts · Number 1.

Nature does not just "cover" the polar bear. She adequately protects him against the loss of body heat with a coat of efficient insulation.

In industry, where losses from heated piping and equipment give so little evidence of their presence, it is sound practice to specify only those insulations which have a proven record of high performance. For nearly half a century, Ehret's 85% Magnesia has demonstrated its unusually high thermal efficiency in practically every type of industrial service.

In addition to 85% Magnesia, the Ehret Company provides insulation for every industrial requirement, and there are Ehret Contractors or Distributors in all principal cities.

SAVE HEAT WITH · EHRET INSULATIONS ·

EHRET MAGNESIA MANUFACTURING CO.

VALLEY FORGE · PENNSYLVANIA

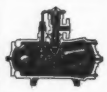
MAKERS OF INDUSTRIAL INSULATIONS FOR MORE THAN 40 YEARS

How COCHRANE MULTIPORT DRAINER permits Quick drainage of Large Quantities of condensate

INLET AT TOP: NO POSSIBILITY OF BECOMING AIR-BOUND-DEFLECTOR PREVENTS WATER STRIKING FLOAT
VALVE SEAT, A SLEEVE WITH LONGITUDINAL PORTS REMOVABLE AFTER LOOSENING SCREWS.
GLASS GAUGE WITH GUARDS AND TRY COCKS.
VALVE ABSOLUTELY BALANCED • DOES NOT BIND OR STICK • WATER SEALED • NEVER LEAVES ITS SEAT • SELF-CLEANING • LARGE PORTS HANDLE WATER RAPIDLY • LESS OPERATING PRESSURE TO EXPEL CONDENSATE • NO STUFFING BOXES, PACKINGS, SPRING OR LINKS • NO PILOT VALVES • CAN BE HELD OPEN BY HANDLE ON COVER.

THE "Multiport" principle on which Cochrane Drainers operate is that of a hollow cylindrical valve with a number of longitudinal ports which register with similar ports in the valve seat when the float is in the raised position. The combined capacity of these ports is unusually large which accounts for the valve's extraordinary discharge capacity. Mail this coupon today—

DISCHARGER



DRAIN REGULATOR

BUCKET TRAP

COCHRANE CORPORATION
3123 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me a copy of your Publication 2850 on Multiport Drainers.

Name.....
Firm.....
Address.....
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Consolidating sales, engineering and servicing direction for eleven midwestern states, General Electric Co. now occupies a new $1,500,000 regional headquarters building in Chicago seven stories high, 350,000 sq. ft. of floor space, with latest lighting and air conditioning. One third of the space is allocated to department offices including those of Carboloy Co., Inc., R. Cooper, Jr., Inc., General Electric Contracts Corp., General Electric Supply Corp. and Locke Insulator Co. The rest of the building is utilized for warehouse, display and servicing facilities.

Rock Hill (S. C.) Printing and Finishing Co. has let contracts for a 150,000 lb. per hr. pulverized coal generating unit, through Lockwood Greene Engineers, Inc. The plant includes: Combustion Engineering Co., Inc., steam generating unit; Babcock & Wilcox Co., economizers; Elliott Co., feedwater heater; Grinnell Co., piping, and Goulds Pumps, Inc., pumps.

In its Quarter Century Number of Freyn Design, the Freyn Engineering Co. describes remodeling of a furnace at Edgar Thomson Works of Carnegie-Illinois Steel Corp., discusses furnace design in Great Britain, plate mill design in Holland, pneumatic sludge transport and developments in blast furnace control and operation.

Battelle Memorial Institute announces further appointments of university or college graduates with aptitude for research, preferably with experience in physics, chemistry, metallurgy, fuels or ceramics, as research associates for a year's experience to develop research men for industry. Appointment is for one year with vacation, carries salary of $1800 and may be extended for a second year. Work is on approved, assigned research projects, of fundamental or general value, leading to publication useful to science or industry. Application should be made not later than April 1, 1941, to Clyde E. Williams, Director Battelle Memorial Institute, Columbus, Ohio.

Conference on Food Preservation will be held at University of Texas, Austin, Tex., March 13 and 14 under direction of Professor Byron Short and Dean Willis R. Woolrich. It is under sponsorship of American Society of Refrigerating Engineers. Subjects to be discussed are Quick Freezing and Dairy Products for March 13; and Locker Storage and Sanitation of Frozen Foods for the following day.

Speaking recently on National Defense before engineering groups in Syracuse, William A. Hanley, president of The American Society of Mechanical Engineers, advocated graduation of the engineering classes of 1942 at least three months in advance of the regular date. Mr. Hanley said that 14,000 engineers will graduate from universities in the U. S. in 1941 but many more will be needed. He suggested that the engineering schools continue through the summer months of 1941 with intensive study so that the class of 1942 can be graduated in February of that year. According to his statement, one industrial concern is now planning to take on 1400 graduate engineers before July, 1941. These

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Power Scrapers

Handle Coal The *Economical* Way

● Maintenance and operating records of hundreds of Sauerman installations (like the one above) show an average cost of less than 3c per ton for storing and reclaiming coal. Because Sauerman installations all over the world, under hundreds of varying working conditions, are turning in records like this, it would pay to investigate this economical, easier way to handle coal—in and out of storage. Simple, automatic operation; better, combustion-free piling are more of the advantages of the Sauerman system.

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Guide Posts To Buying

Reading the advertising messages that appear in POWER PLANT ENGINEERING is a profitable habit to acquire. They provide the latest information on what's new and useful in the power plant market. They serve as dependable guide posts to buying.

ROUND BOLTED BONNETS

- **Approved by Construction Codes:**
  Round Bonnets meet all requirements for low or high pressure services.
- **Minimum distortion under pressure:**
  Pressure vessels tend to assume spherical shapes under stress. Only round bonnets keep distortion under pressure to a minimum.
- **Lowest Maintenance:**
  Use of round gaskets cut maintenance costs to the bone. No "fussing" with rectangular, oval and other odd shaped templates and gaskets.
- **Prolonged Service Life:**
  Vogt Bonnets and Bodies have the recognized wide safety margin of DROP FORGINGS. This, combined with correct design and proper materials assures continuous operation with highest operating efficiency.

Vogt BOLTED BONNET VALVES

UTILIZE THE *Round* BOLTED DESIGN
for ALL SIZES and ALL PRESSURES
THIS INCLUDES *EVEN* THE LOW-PRESSURE
150 AND 300 POUND VALVES

HAVE you a copy?

Vogt's complete line of Drop Forged Steel Gate Valves is described in this brochure. Sent upon request.

HENRY VOGT MACHINE CO., INC.

LOUISVILLE, KENTUCKY

NEW YORK • PHILADELPHIA • CLEVELAND • CINCINNATI
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DROP FORGED STEEL VALVES

How To Tell If BOILER PERFORMANCE Is Below Par

THROUGH the accurate totalizations of flow of Boiler Feed and Turbine Condensate provided by the new Simplex Gyrometer you can readily detect the causes that are responsible for under-par boiler performance.

The Gyrometer is equally accurate and reliable when used for measuring Steam, Air, Gases and Corrosive Liquors. It is designed for use with orifices, nozzles or venturis. Low in first cost and requires minimum maintenance.

Let us show you how this inexpensive and reliable unit can help you solve your plant metering problems. Write for descriptive bulletin.

SIMPLEX VALVE & METER CO.
6790 Upland St. Philadelphia, Pa.

SIMPLEX
•
GYROMETER

conclusions have been arrived at after a visit in the last few days to New York, Philadelphia, Hartford, Worcester, Boston and Schenectady where industrial concerns co-operating on the defense program have explained the great scarcity of young engineers for this most vital job.

Effective March 1, 1941, Sarco Company, Inc., 183 Madison Avenue, New York, N. Y., manufacturers of steam specialties, announce the removal of their head offices to 475 Fifth Avenue, New York, N. Y., where they will occupy the entire 24th floor.

NEWS FROM THE FIELD

C. R. Messinger

C. R. MESSINGER, President of Chain Belt Co., continuously identified with Milwaukee and Chicago business interests for more than 30 yr., died suddenly of a heart attack on February 4, 1941, at his home in Milwaukee. His death followed that of Mrs. Messinger by approximately a month.

Mr. Messinger was born in New Haven, Conn., Oct. 28, 1883. He graduated from Sheffield Scientific School of Yale University in 1906.

Mr. Messinger's initial business experience was in the Plant and Sales Department of the Harbison-Walker Refractories Co. of Pittsburgh. In 1909 he was in charge of their Chicago office, but left the company to become Secretary of the Sivyer Steel Casting Co. at the time of its organization. He later became Vice President and General Manager, then President and General Manager, and was Chairman of the Board at the time of his death.

In 1917 he became affiliated with Chain Belt Co. as its Vice President and General Manager; he had been named a Director in 1916. In 1923 he was elected President and in 1931 became Chairman of the Board. Also, in the same year he was elected President of Oliver Farm Equipment Co. and in 1935 was named Chairman of its Board.

In addition to his business connections he was connected with various civic, charitable and educational undertakings, and at the time of his death was a Director of the Milwaukee Community Fund, Milwaukee Country Day School and Columbia Hospital of Milwaukee. He was Vice President of the Yale Engineering Association and a member of the Executive Committee of the Yale Alumni Board, Finance Committee of the Milwaukee Children's Hospital, Chi Phi Fraternity, Sons of the American Revolution and the American Society of Mechanical Engineers.

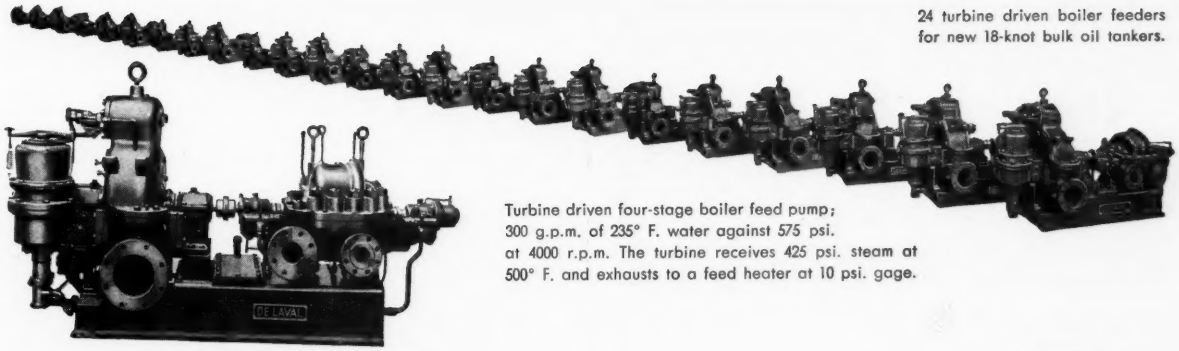
Mr. Messinger is survived by three sons and one daughter.

Joseph J. Blackmore

JOSEPH J. BLACKMORE, a charter member of the American Society of Heating and Ventilating Engineers and its Secretary in 1914 and 1915, died on February 11, 1941, after a brief illness at the home of his daughter, Mrs. David G. Wagner, in Brooklyn, N. Y. He was 85 yr. old

Mr. Blackmore was born November 22, 1856, in Yorkshire, England, and came to Toronto, Canada, as a boy. A pioneer in the heating industry and for many years associated with J. L. Mott Iron Works, and on the formation of the United States Radiator Corp., Detroit, Mich., in 1910 he served as Secretary until his retirement in 1915. He was one of the few surviving charter members of the Society, having joined in 1895, and for the past 10 yr. has been a life member of the organization. He contributed many papers to its transactions and served on numerous technical committees, as well as a member of its Council.

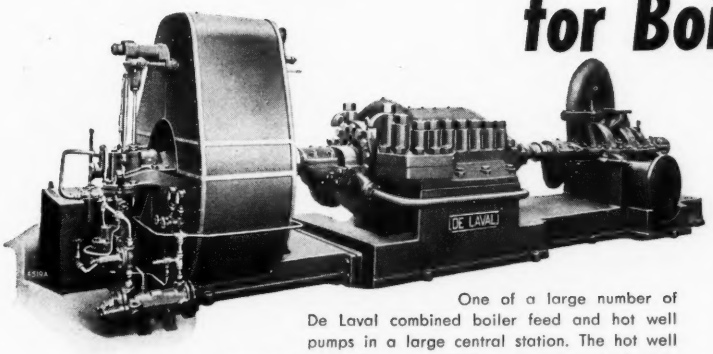
His unique hobby which he pursued since his retirement was spent traveling around the world. Since he took to golf at the age of 45 he has kept a record and retained the score cards of his games played on over 800 different golf courses in the United States, South America, Europe, Australia and New Zealand He played golf at 13,400 ft. above sea level in Bolivia and from this



24 turbine driven boiler feeders for new 18-knot bulk oil tankers.

Turbine driven four-stage boiler feed pump; 300 g.p.m. of 235° F. water against 575 psi. at 4000 r.p.m. The turbine receives 425 psi. steam at 500° F. and exhausts to a feed heater at 10 psi. gage.

ADJUSTABLE SPEED *for Boiler Feed Pumps*



One of a large number of De Laval combined boiler feed and hot well pumps in a large central station. The hot well pump receives 1570 g.p.m. of 102° F. water at 2 psi. absolute and discharges against 210 psi. gage. The boiler feed pump receives 1455 g.p.m. of 260° F. water under 169 psi. gage and discharges against 1186 psi. gage. The turbine, running at 1770 r.p.m., receives steam at 815 psi. gage and 900° F. and exhausts against 5 psi. gage.

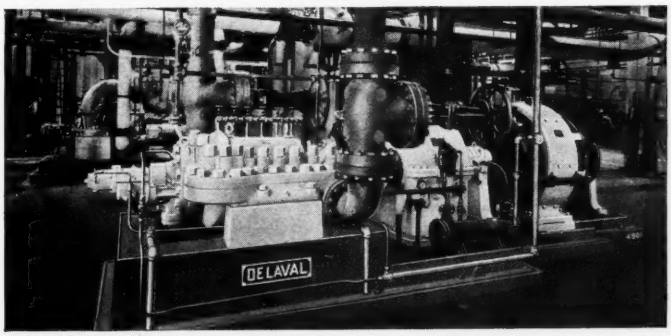
In feeding a boiler, the point where constant excess pressure is required is at the regulator valve. At maximum load, the drop through piping, feed heaters and economizer may amount to 50 lb. or more, and if pump speed is held constant power will be wasted at lesser loads. Adjustable speed is readily obtained by using a

DE LAVAL TURBINE DRIVE

In large units and where the turbine exhaust is used in feed heaters, turbine drive competes in dollar economy with electric drive, besides offering greater security against shutdown.

With motor drive, variable speed can be had with a D.C. or wound-rotor A.C. motor or by using a hydraulic coupling. Slow speed motors are the most adaptable to speed control, but a De Laval speed increasing gear will permit of selecting the pump speed that is best for efficiency and good construction.

Ask for Catalog P-3616



Boiler feed pump driven by variable speed D.C. motor through speed increasing gear. Maximum speed of motor 1185 r.p.m.; pump 2475 r.p.m.; to deliver 1185 g.p.m. of 350°F. water from a suction pressure of 500 psi. to a superposed boiler at 1085 psi. The shaft packings of the pump are protected from high pressure by labyrinth pressure breakdowns and leak-off chambers at each end of the pump.

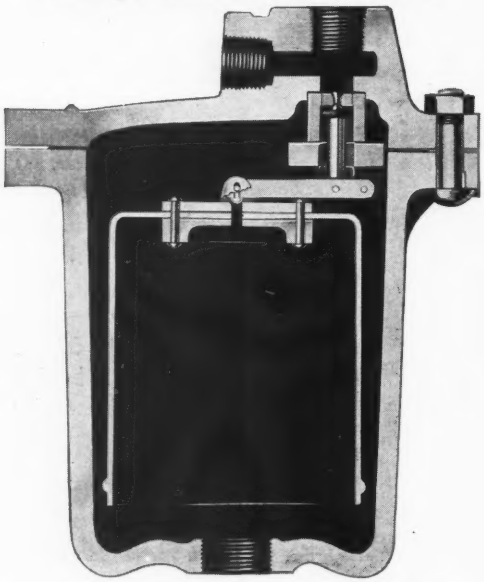
DE LAVAL *Steam Turbine Co.*
TRENTON, N.J.

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC, PUMPS . . . CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING, CENTRIFUGAL BLOWERS and COMPRESSORS, GEARS . . . WORM, HELICAL and FLEXIBLE COUPLINGS

PIPEWRENCH PETE SAYS:

Here's Why STRONG Inverted Bucket Traps DON'T BALANCE!

Exclusive "Trigger" Vent Gives Sharp, Intermittent Action



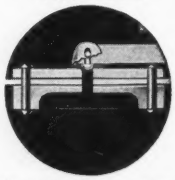
Saves on Production, Steam, Upkeep!

Now, STRONG gives you inverted bucket traps with an exclusive "trigger" action vent that ends balancing once and for all!

Full, intermittent operation, plus Anum-Metl seats and discs, plus wear-proof parts permit us to guarantee STRONG traps a full year against leakage or wear.

Write for your copy of catalog 63-PE12 today!

Here's The STRONG "Trigger" Vent!



While bucket floats, valve almost closes vent. As bucket fills and reaches point of discharge, it starts to sink, removing valve from vent. This allows large quantity of air to escape suddenly, and causes bucket to sink to the bottom. Assures full, intermittent action.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

extreme he played on the Furnace Creek Course in Death Valley, Calif., 272 ft. below sea level. He once made the statement, "I played my first game in Brooklyn in 1902 and my best game when I was past 73."

For the last 20 yr. Mr. Blackmore has made his home at the Engineers Club, 32 West 40th St., New York, and has spent his winters in Florida.

Steam Plant Engineers Wanted

Seeking a Chief Steam Plant Engineer, the City of Burbank, California, has just announced a civil service examination open to qualified men all over the country. The beginning salary for the position is $300 a month, with later advancement to $330. An examination is also being held at the same time for the position of Steam Engineer, with salaries of $210 to $240 a month.

The City of Burbank is a suburb of Los Angeles and is an important center of the rapidly expanding aircraft industry. Its 1940 population was approximately 40,000.

The examinations are being given to fill positions on the operating staff of a new steam-turbo electric generating plant. The plant has boilers operating at 625 lb. pressure, fired with both oil and gas with full automatic combustion control and the steam temperature will average 825 deg. F. A 4500-v. 10,000-kw., 3600 r.p.m. generating unit has been installed. A second unit, a duplicate of the first, will be in operation in about a year.

Men between the ages of 30 and 55, with an engineering degree and at least five years' recent experience on the operating staff of a turbine-driven steam electric generating plant, of which two or more have been in a responsible supervisory capacity in a plant equipped with one or more units of not less than 5000 kilowatt capacity, are qualified to file applications for the examination for Chief Steam Plant Engineer. One additional year of supervisory experience, as described above, may be substituted for each year of university training lacking.

For the position of Steam Engineer, men between the ages of 25 and 50 who have a high school education and at least 4 years' recent experience on the operating staff of a turbine-driven steam electric generating plant, at least one year of which must have been in a plant equipped with one or more units of no less than 5000 kilowatt capacity, are qualified to file applications to take the written examination. One additional year of experience can be substituted for each year of high school education lacking.

Application blanks and additional information regarding the two examinations can be secured by writing to the City Manager, City Hall, Burbank, California. Applications must be filed by Friday, March 21, 1941.

Plant Personnel

AS AN example of carefully planned practice in the problem of getting and training workers in a power plant organization, the following from a 5000-hp. industrial plant in New York State will be of interest.

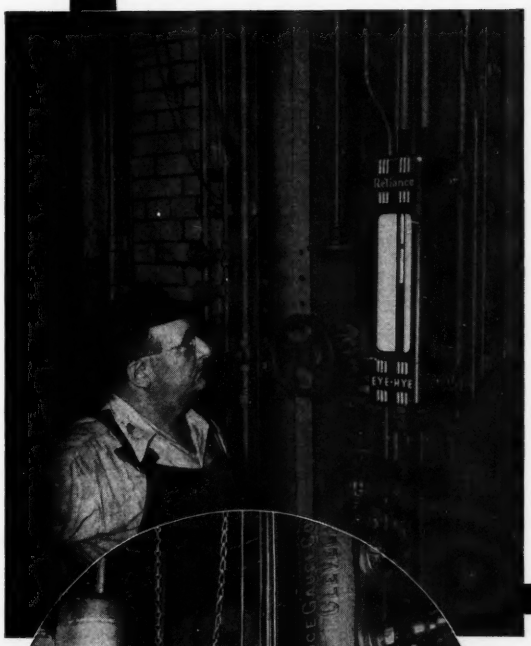
In placing men it is the custom to promote men in the organization, if a suitable man is available, who has qualifications to take over the new responsibilities, has the knack of leadership, has done satisfactory work and is happy in the organization. Naturally, this requires some doing. It is difficult to choose a man of shorter service over one with long service, but the necessities of the case must be considered. While it has been a practice to have a foreman or other minor executive name the man whom he recommends as his successor, this may cause future trouble, as personal feelings are likely to enter and somebody farther away from the job is likely to have a broader view of its requirements. He will not, however, know the abilities of the men so well, hence a list of several named by the foreman, with summaries of his reasons for the choice may well be submitted to a higher executive, or to a committee for consideration and final choice.

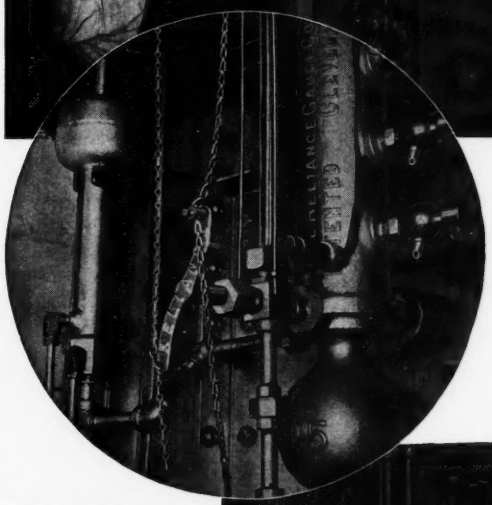
When choice has been made, the man is trained on the job, whether it is a promotion or a new

You know you have *Power Security*

when your boiler water levels are under the smoother dual patrol of **Reliance** ALARM and EYE-HYE....

like thousands of important plants all over the country.





Reliance ALARM and EYE-HYE play an important part in maintaining strict control of boiler water levels in the Acme Breweries at San Francisco. No. 5 ALARM and No. E-12 EYE-HYE protect the 175 lb. pressure boilers.

★

YOUR final check on boiler water levels is the eye and the ear of the man whose job it is to be constantly on the power plant floor. In him rests the responsibility of keeping power flowing for the vital production schedules you are striving to maintain. • If feed water supply fails, it's a satisfaction to know that your Reliance ALARM will sound a loud warning if water drops too low; or if it gets too high for safe and efficient operation. But long before the Alarm gives its signal, operators usually *see* any discrepancy when they have the illuminated EYE-HYE Gage, to audit with a glance when checking other instruments. For EYE-HYE transfers the conventional water gage reading to wall or instrument panel, at eye level, accurately indicating the exact water level • ALARM and EYE-HYE—the Reliance Safety Team—should be on every boiler. Not costly, yet honestly made, with models to suit any conditions. The thousands of engineers who have depended on Reliance Devices for years tell you how completely their water level worries have been forgotten. Write today for Safety Team information.

THE RELIANCE GAUGE COLUMN CO.

5902 Carnegie Ave., Cleveland, Ohio

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TRADE MARK REG. IN U.S. PAT. OFF.

Boiler Safety Devices since 1884

IN A HURRY?

Get it Tight the First Time with a DART

There's no try-try-again for tight joints—no costly delays—when you hook-up with Darts. For Darts make up *tight the first time*, quickly, easily. They're made that way. They've got two bronze seats, ground and matched for quick, sure tightness. Extra heavy malleable iron bodies and nuts, to minimize stretch and withstand wrench abuse. And remember this. A Dart is good for more than just one tight joint. You can install it again and again and get tight joints every time. Next time you ask for a union, ask for a Dart.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

employe, learning the particular problems of the plant, and the company's policies, rules and practices.

For a new man, his experience and qualifications are secured and compared with the needs of the job; then, if suitable, the man under whom he is to work has an interview to determine how he will fit in the organization.

Rules and Policies

For the whole plant, these are formulated by the manager, those pertaining to the power department being evolved by the Manager of Engineering, working with foremen and the men in the organization. This ensures that general company policies are carried out but embodies the thought of the power plant men as to the details regulating their own work, which makes for satisfactory co-operation. Inculcation of these policies and rules is by messages read by a department head to employes in his department, by meetings of management and supervisory force and by department meetings for discussion of debatable points. This usually results in settlement by agreement, but, if not, any question can be taken to a higher executive for decision.

It has been felt in this plant that full understanding of the importance of power in production and the necessity of uninterrupted and economical power supply is more effective than special bonuses or pay inducements in securing satisfactory performance. The wage scale is, of course, adequate. But it is felt possible that some pay inducement might be helpful where extra arduous work is necessary, and this may be worked out later. It would be interesting to know what experience other plants have had with a bonus or other inducement system, especially for suggestions for improved practices.

Personnel Relations

Group insurance, which pays benefits to workers for sickness, but not to families, is in force, and some departments have organized, on their own initiative, hospitalization groups. Group life insurance has not been put in force.

Social activities include departmental parties at Christmas and athletic activities at all seasons, such as bowling, basketball and baseball. These are handled by those interested, not as a company project but are given company backing as seems desirable, avoiding any paternalistic attitude.

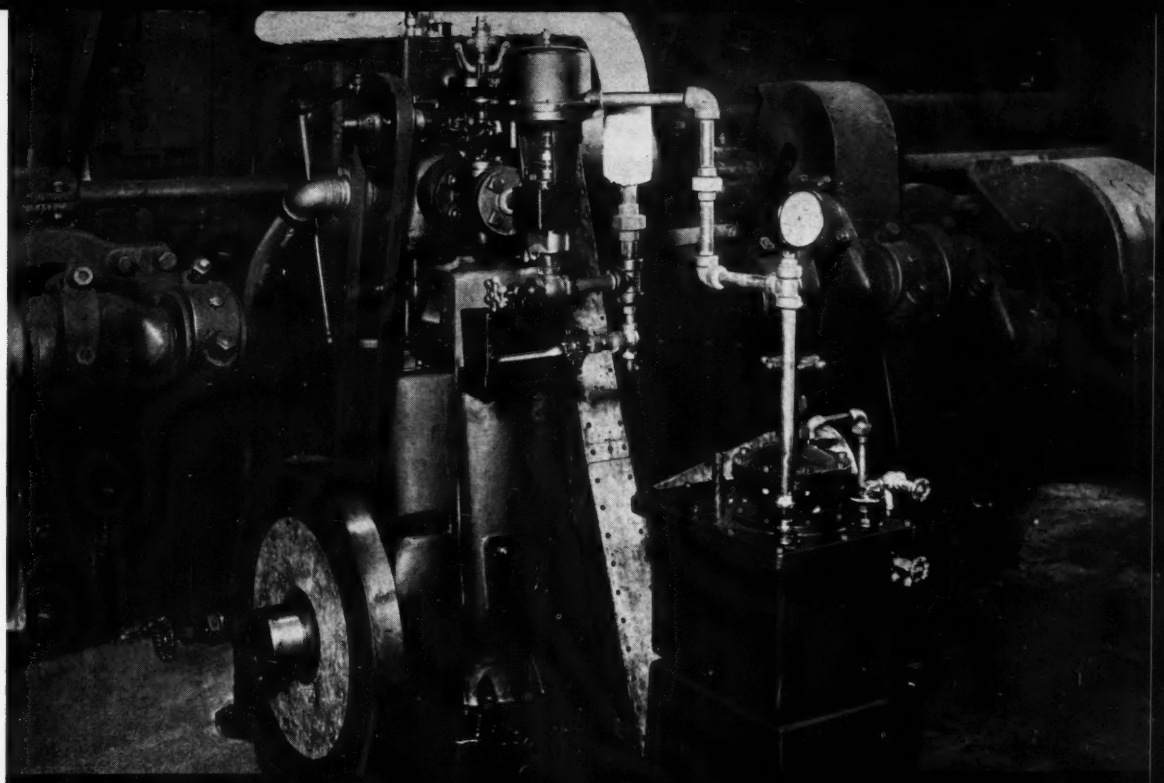
Two saving fund organizations are operated on the same basis, and have proved helpful in improving employe morale.

The organization is of moderate size, hence lends itself to a family spirit. This is the condition in the majority of plants outside large utilities, hence the methods followed should have wide application in industrial plants.

U-235

THIS NEW substance, 1 lb. of which is estimated as equivalent in energy to 2,600,000 lb. of coal has been the subject of much newspaper and magazine writing, a good part of it as usual highly spiced with imagination. It is interesting, therefore, to get real facts as presented by the research department of Synchroscope of the Detroit Edison Co.

U-235 is a special type of uranium atom whose weight is 235 times that of hydrogen. Uranium has been known since 1789 and is used in industry for coloring porcelain and glass and as a minor constituent in alloy steel. For 2 yr. Dr. Leis Meitner a



24 TROY-ENGBERG STEAM ENGINES

SELECTED TO DRIVE 48 STOKERS IN LARGE POWER STATION

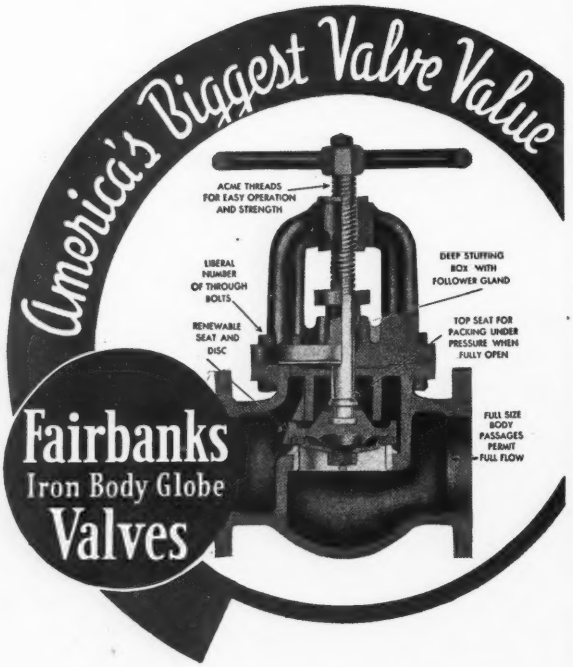
Here's one for the book! In carrying out recently an extensive modernization program, the engineers of the huge 59th Street Power House, I.R.T. Division of the New York City Transit System, selected steam engines to drive the 48 stokers. Each engine drives two stokers.

Why steam engines?

Maximum flexibility under precise automatic control, that's what was wanted. Obviously, this power house is confronted with widely fluctuating loads including several peak loads during the day. It requires maximum boiler flexibility, hence maximum stoker flexibility, and this is what the modern steam engine can give.

Every company now operating boilers with widely fluctuating loads or planning the installation of such boilers should give fullest consideration to the use of Troy Steam Engines as drives for the stokers if flexibility combined with economy is desired.

TROY ENGINE & MACHINE COMPANY
Established 1870 TROY, PENNA.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ACME THREADS FOR EASY OPERATION AND STRENGTH
LIBERAL NUMBER OF THROUGH BOLTS
RENEWABLE SEAT AND DISC
DEEP STUFFING BOX WITH FOLLOWER GLAND
TOP SEAT FOR PACKING UNDER PRESSURE WHEN FULLY OPEN
FULL SIZE BODY PASSAGES PERMIT FULL FLOW
Fairbanks
Iron Body Globe
Valves

Where else will your valve dollars buy such outstanding value as in this Fairbanks Iron Body Globe Valve?

Where else will you get valves made of a semi-steel of a tensile strength 66⅔% greater than ordinary cast iron . . . that have a seat and disc which can be renewed in a few minutes right on the pipe line . . . with back seating on spindle to permit repacking under pressure . . with strong deep-cut threads . . . with guides in body to insure perfect seating of discs . . . bushed throughout to insure long, dependable service.

Only when you try one of these Fairbanks Valves will you believe that any valve could operate so easily, close so tightly and cost so little for maintenance.

Get a "close-up" of the biggest valve value by asking your Fairbanks distributor to compare this valve, part for part, with any other.

Write now for catalog No. 21.

THE FAIRBANKS COMPANY
399 Lafayette St., New York, N. Y.

Valves, Dart Unions, Hand Trucks and Wheelbarrows

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German refugee and Dr. Otto Hahn had been working on the possibility of atomic power in uranium and, while en route to Stockholm, Dr. Meitner concluded that they had split the uranium atom. Report of this was published in scientific journals and others took up the research. Professor Niels Bohr at Princeton working with the three types of uranium atom, U-234, -235, and -238 found the U-235 gave best results under the bombardment of streams of neutrons. It was known that in 140 lb. of uranium there was only 1 lb. of U-235 and a pure sample of it had never been obtained, but Dr. Alfred O. Nier at University of Minnesota finally isolated a tiny sample, and later G. E. laboratories obtained a larger but less pure quantity.

In January 1940 four French research men found indications that splitting of uranium was a chain reaction, additional neutrons being released and then bombarding other atoms, which in turn are split and so continue the process, like a bunch of fire crackers being set off by the first one lighted.

Energy is released in the splitting which for U-235 amounts to 31,000,000,000 B.t.u. per pound or equivalent to 1300 t. of coal, and by placing U-235 in water the process can be controlled, also the heat can be utilized to generate steam. This is the theory, which sounds simple. But nobody has been able to test it out because there is no amount of U-235 sufficient for tests. Dr. Nier ran his equipment 24 hr. a day for 10 days to get 1036 millionths of a gram, at which rate it would take 11,995,074 yr. to get 1 lb.

Professor W. Krasny-Ergen of University of Stockholm was last year building apparatus which was expected to produce U-235 at the rate of 1 lb. in 960 yr., evidently not yet mass production, but invasion of Norway stopped the work. If successful, the multiple use of 100,000 units could produce 1 lb. in 4 days, but this is purely speculation. Production of U-235 in quantity may be possible in 10 yr. or not for generations, or never. As 1 lb. has explosive power equal to 15,000 t. of TNT, it is to be hoped that methods of handling and control will be developed before any considerable amount is available. At any rate, it is not likely to be available as a cheap source of power for many years, as cost of production is likely to be prohibitive.

In the process for separating U-235, an atom, which has a nucleus of 92 protons whose weight is 1 and positive electric charge 1, each, is surrounded by a hollow sphere of 92 electrons each having weight of 1/1850 and negative charge of 1. This atom is bombarded by a stream of electrically driven neutrons, with no charge but weight of 1, each. Fast moving neutrons will miss the nucleus and pass between the electrons. Some slow neutrons will swing in and hit the proton nucleus, splitting it into two parts, thus producing heat.

Several atom smashers are in the course of construction or in use and progress will undoubtedly be made but at first is likely to be slow and costly.

Research Grows Up

On Dec. 17, 1940 was held the celebration of 40 yr. work of General Electric Research Laboratory with Dr. Karl T. Compton, president of M. I. T., Charles E. Wilson, president of G.E. and Samuel Ferguson, president of Hartford Electric Light Co., who was the first engineer of the laboratory, as speakers.

It's not packing— it's* RE-packing *that's really expensive . . . that's why it pays in dollars and cents to use the best packing money can buy. J-M Sea Rings are that kind of packing.

They're custom-made to fit specific operating conditions. Entirely automatic, they seal on the work stroke, release on the return, thus reducing friction and wear on both packing and rod. During the past 25 years many engineers have accepted Sea Rings as the standard packing for reciprocating rods and plungers operating against steam, water, air, brine, oil, gasoline and many other fluids and chemicals.

For details on J-M Sea Rings and the complete line of J-M Packings and Gaskets, write Johns-Manville, 22 E. 40th St., New York, N.Y.

JM

Johns-Manville PACKINGS & GASKETS

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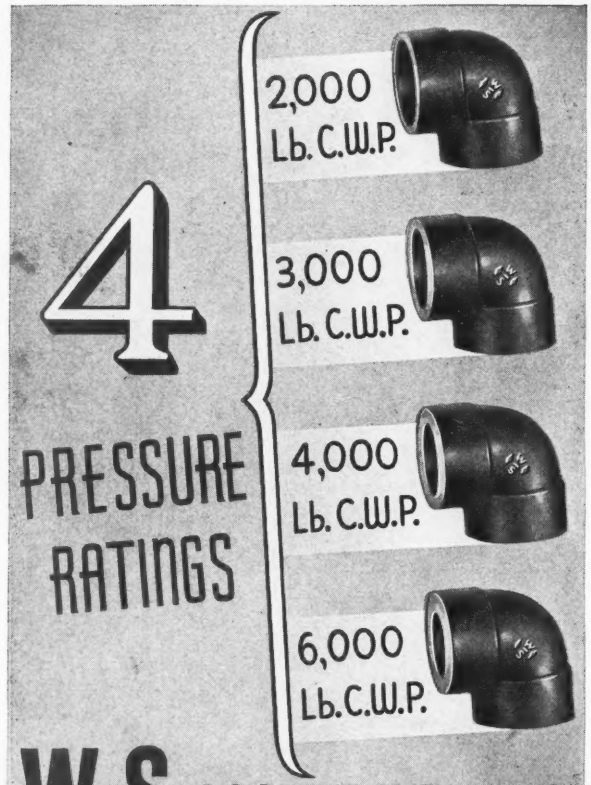


W-S SOCKET WELDING FITTINGS

For power plant, refinery, refrigeration and air conditioning, no matter what your piping needs may be, you'll find that W-S Socket Welding Fittings simplify and speed up installation.

Deeper sockets eliminate the necessity of cutting pipe to exact length. No tack welding, no special fixtures for lining up and holding the joint are necessary. The deep socket furnishes support for the pipe and provides for self-alignment.

Use W-S Fittings with Schedule 40, 60, 180 and double extra heavy pipe. A complete range of sizes and types in forged carbon and alloy steels.

Specifications, dimensions and prices on the complete line are listed in Bulletin A-3. Write for your copy now.
THE WATSON-STILLMAN CO., ROSELLE, N. J.

WATSON-STILLMAN
Forged Steel Fittings

Initiation of the laboratory was in the barn of Dr. C. P. Steinmetz, who with Albert G. Davis, then head of the patent department made the suggestion to E. Wilbur Rice, then vice-president for a laboratory to investigate improvement of the incandescent lamp.

Mr. Davis said, "But these things can't go on without research." Now that was just what Mr. Rice had been thinking, a laboratory separate from the factory and sales branches. So the directors approved the idea, with the caution that Mr. Rice use care in getting the right man.

Thus the beginning in Dr. Steinmetz's barn with Dr. Willis R. Whitney of M. I. T. coming three days a week to experiment with Steinmetz and the staff, which consisted of one man, J. T. H. Dempster known as Tom. The house still stands but the barn was burned soon after it started as a laboratory, a first result of research, maybe? Then a building in the G.E. plant, built for a standardizing laboratory was taken over and used until 1901 when, because of spring floods, it was removed to the standardizing laboratory building. In 1904, research acquired a home of its own and later into the two massive brick buildings now occupied.

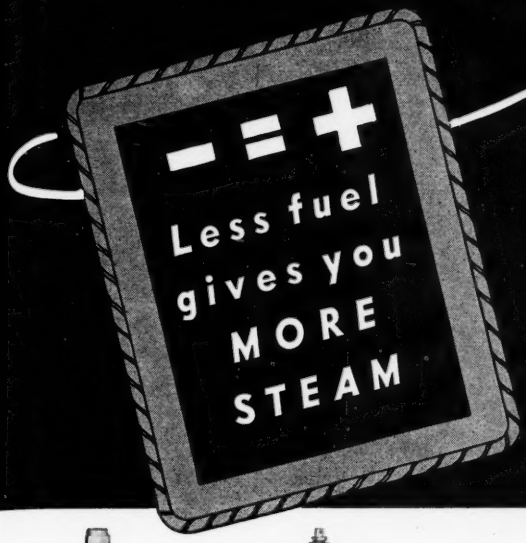
House of Magic was the name given it by Floyd Gibbons and the name is fitting, in view of the way it has expanded in 40 yr., under the guidance of Dr. Whitney until his retirement, and since under Dr. William D. Coolidge.

Water Treatment For Cooling Systems

In an address on this subject before the 4th Alabama Water Conference, an entirely new method for attacking water treatment was described by D. W. Haering, president of D. W. Haering & Co., Inc., of Chicago.

He stated that six model cooling towers of orthodox construction are the principal features of the atmospheric cooling systems. The systems, less than 3 gal. in capacity, are complete with small centrifugal pumps, heat exchangers, control valves, spray headers and all essential piping. A large ventilating fan provides equal atmospheric conditions for all six towers. Rates of flow, temperatures, atmospheric conditions, and chemical conditions in the system waters are under the direct control of laboratory engineers. Data collected from past test runs have proved the accurate simulation of industrial operating conditions by the small systems. Both natural and synthetic waters have been employed in recent experiments and prove the practical use of a carefully prepared synthetic water for such purposes. The absolute necessity for complete simulation of industrial operating conditions by the cooling systems and waters employed was stressed emphatically.

Scale, corrosion, and living organism problems encountered in industrial cooling systems are being studied in the small units. At present, an extensive study of the effects of various isolated ions upon corrosion in such systems is being conducted.



Make this come true by PUTTING CASH STANDARD AUTOMATIC COMBUSTION CONTROL TO WORK IN YOUR BOILER ROOM

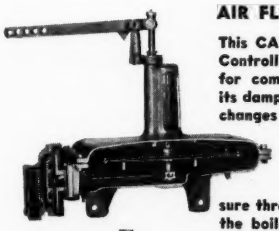
FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.

Cutting your fuel bill and yet getting more steam whether you have a stoker, pulverizers, oil burning or gas firing equipment on your boilers, is but part of the benefits you get with CASH STANDARD Automatic Combustion Control — in addition, when you install this modern low-cost control you will greatly reduce your maintenance costs — you will make it possible for your boiler room operators to have much more time for other duties — you will hold your steam pressure within close limits.

CASH STANDARD Automatic Combustion Control is NOT delicate — it WON'T get out of order — and you will find that with this control you maintain the fuel air ratio that is correct for economical combustion.

The CASH STANDARD Furnace Draft Controller works independently (read description at left). Placed properly on your boiler it gives you an immediate start on the money saving benefits of Automatic Combustion Control. You can make this first step for as little as $98. You will find it a good paying investment for, with it, you automatically eliminate air infiltration — decrease the volume of air handled by the furnace — reduce gas velocity through the boiler — allow correct time for heat absorption — increase furnace temperature — insure higher CO_2.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

You get Fuel Feed Controller — Air Flow Controller with Operating Power Cylinders (as in the Furnace Draft Regulator), and necessary connecting fittings with many daily cost-saving benefits for as little as $290.

FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

★ There is no difference in the quality or design of these units and those we furnish for the most elaborate jobs and the largest kind of boilers. To make this plan workable, the simple requirement is that the control units be installed conveniently near the apparatus they operate without panel board.

OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator — price $108. equipped with 110-220 v. 60 cy. motor.

★ Don't hesitate to write for more details — all of the interesting, important facts are contained in Bulletin No. 300 — ask for a copy — no obligation.

A. W. CASH COMPANY
DECATUR ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

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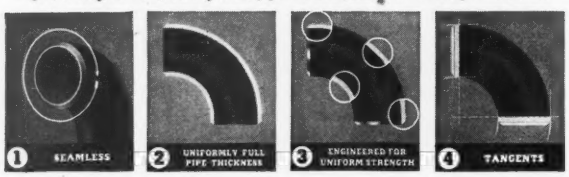
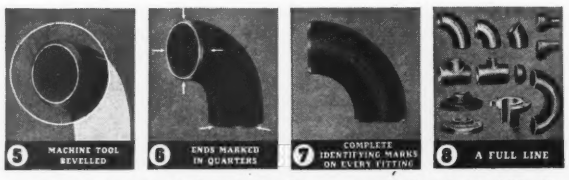


On your next job

make the acquaintance of the only welding fittings that offer you all these 8 aids to faster, easier welding.



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FOR THE ENGINEER'S LIBRARY

Coupon for obtaining free literature listed here may be found on page 142, under the heading Helpful Bulletins.

Instruments and Controls

1 Balances—Illustrated and described in a new catalog and used for delicate work and weighing in milligrams are the new precision balances, models B, C, and D, which have a range of from 3 to 1000 mg. Included in this catalog is a special balance for measuring surface tension of liquids. Roller Smith Co.

2 Tachometer—New Standco hand tachometers are illustrated and described in Bulletin 750, covering speeds from 30 to 48,000 r.p.m. in five ranges. They are of size to fit the hand, with large dials to measure r.p.m. and f.p.m. direct. Herman H. Sticht Co.

3 Recorder Operation—Brown New-Matic Remote Transmission is the subject of a new catalog No. 9400 which describes the construction and uses of transmission for control and recording of temperature, pressure, flow and liquid level, in situations where electrical transmission is not adapted. Clear illustrations of interiors and exteriors with diagrams of applications and accessories are included in this catalog. Brown Instrument Co.

4 Liquid Level Gages—A new catalog, No. 1015, has recently been published, describing float, pressure-bulb, pressure, air-bubbler, counterpoise and differential pressure type water and liquid level gages for all types of applications, including the measurement and automatic control of liquids in open vessels, as well as in closed vessels where the surface of the liquid is under static pressure. With these instruments the level of almost every kind of liquid, whether flowing, turbulent, corrosive, covered with ice or carrying solid matter, can be recorded, indicated or automatically controlled. The Bristol Co.

Electrical Equipment

5 Relays—Centrifugal-speed relays for indicating and controlling relative speeds, in Type GCR-10 for automatic or manual reset and speeds of 70 to 4000 r.p.m. are described and fully illustrated in catalog GEA-3047A. General Electric Co.

6 Voltage Regulators—A new Bulletin B-6137 on type VD Rocking Contact Voltage Regulators has recently been released. This descriptive bulletin, well illustrated by photographs and wiring diagrams, shows how these regulators may be applied to direct current problems in steel mills, paper mills, electro-plating and chemical plants, and in the process industries. Another bulletin, known as B-6126, describes a new dry type air cooled regulator for feeder voltage regulation. Allis-Chalmers Mfg. Co.

7 Speed Control—Packaged power in an adjustable-speed drive for small units, (1 hp. and up) is described and illustrated in Bulletin 310. Reliance Electric & Engineering Co.

8 Switchgear—Why FH Cubicles? is the title of a new 24 pp., bulletin GEA-2599, telling why cubicles are advantageous, emphasizing the safety, strength and savings features. General Electric Co.

9 Transformers—A new distribution transformer bulletin, B-6125 covers sizes ranging from 37½ to 200 kv-a. designed for standard voltages of 2400 to 69,000 v. 16 well-illustrated pages cover the design and construction features, including dimension sheets. Allis-Chalmers Mfg. Co.

10 Circuit Breakers—Two new catalogs on circuit breakers have recently been released, No. 3650 illustrates and describes outdoor type in one to four-pole breakers for 600 to 1200 amp., 15,000 and 23,000 v. and 250,000 kv-a. interrupting capacity. No. 3940 deals with the subway type, 2 and 3 pole, 200 and 400 amp., 7500 v. non-automatic, single-throw. Roller-Smith Co.

11 Photometers—Photometers and illuminometers for lamp testing, lighting surveys, photometric research and educational use are described in detail in the new 20 pp. catalog E-72. Included in this well-illustrated booklet are descriptions of the bar photometer, sphere photometers (both visual and photo-electric types), and the Macbeth illuminometer. Leeds & Northrup Co.

Ask to see the

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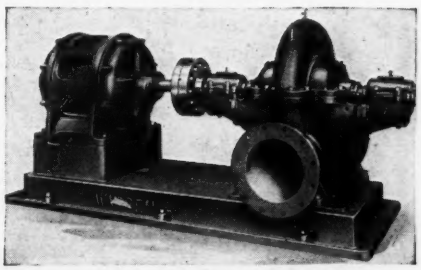
We welcome investigation of a Warren Pump's reputation and character. We welcome investigation because it shows that Warren Pumps work hard, save power, keep well and live a long time. We welcome it because we know that it will mean business for us and satisfaction for you.

Warren Pumps have good details and good details make good pumps. Warren Shafts are extra heavy, bearings are over-size with broad surfaces, impellers are balanced to prevent vibration, case rings have broad surfaces for long wear, clearances are liberal for the maintenance of high efficiency over long periods.

On your next pump replacement or addition it will pay you to investigate Warren.



Warren Double Suction Centrifugal Pump

WARREN STEAM PUMP COMPANY, INC., WARREN, MASSACHUSETTS

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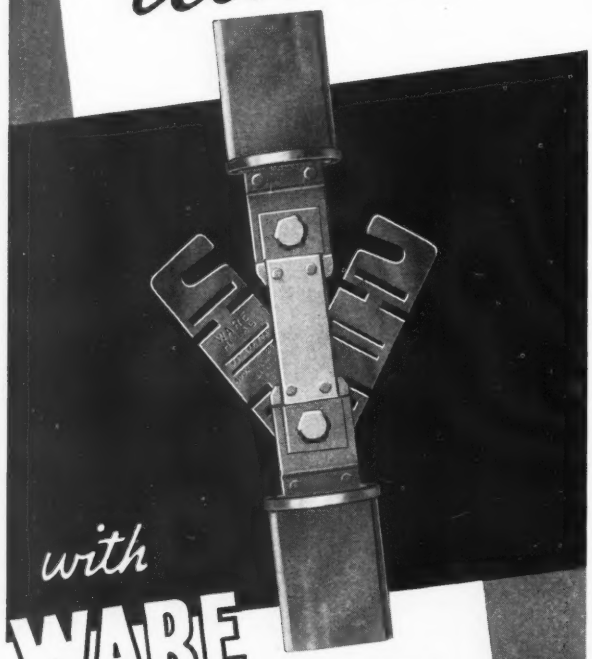

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Start your plant economy program around the improved WARE HI-LAG Fuses.

The exceptionally high time lag of WARE HI-LAG Fuses ends the blow-outs often caused by starting motors and momentary surges.

The new double-bridge, self-aligned assembly used on these WARE HI-LAG Fuses is easy to renew and insures extra strength and longer life. Assembly may be inserted either end first.

WARE HI-LAG Fuses are Underwriters approved; give 100% protection to your circuits; soon pay their cost through saving of lost time. Write for our Trial Test Offer, sizes and prices.

WARE BROTHERS

4500 W. Lake St. **Chicago**

Boilers, Auxiliaries and Fuels

12 **Boilers**—C-E Horizontal Return Tubular Boilers is the title of a new 16 pp. catalog, giving full details of the design and construction of these units, various furnace settings, different methods of firing and a typical furnace arrangement for burning Bagasse. Combustion Engineering Co., Inc.

13 **Continuous Blowoff**—A new Permutit bulletin No. 2591 tells why blowoff is necessary; points out the shortcomings intermittent controls; and discusses several typical arrangements of modern continuous blowoff systems based on flash or non-flash, high or low heat level, single or group control operating characteristics. Various types of heat exchangers, flash tanks, etc., which go to make up these systems are described in detail. The Permutit Co.

14 **Blowers**—Trane fans, Type FC with forward curved blades and Type BI with backwardly inclined blades are described and illustrated, with dimension and performance tables in recently released Bulletin DS-348. The Trane Co.

15 **Dampers**—The Heacon damper which consists essentially of an asbestos curtain which opens and closes by movement around a special motor driven spindle is described in a new 4 pp. bulletin. The damper, adaptable to practically all locations where the conventional damper is used, is simple, rugged, easily installed and said to be unusually leakproof when closed. A supplementary sheet DD-107 shows details of calculating the annual cost of damper leakage considering size, gas temperature, coal cost, etc. Heacon, Inc.

16 **Gas Burners**—Entrained Combustion's Challenge to Waste is the title of Bulletin F-a, 4 pp., showing the design, arrangement and installation of the Mettler automatic motorized fan gas burner assembly featuring a new automoatic safety pilot and triple controls. Lee B. Mettler Co.

17 **Coal**—Booklet No. 1 released in connection with the stoker coal research program describes the effect of stack damper setting or furnace draft on stoker performance. Included in the booklet are tables, charts and data dealing with efficiency, out-put, fly ash, control of heat, etc. Koppers Coal Co.

18 **Pulverized Coal**—C-E Direct Fired Systems for burning pulverized coal is the title of a new 36 pp. catalog in two colors. It incorporates the latest improvements in mills, burners and feeders and shows many of the latest installation drawings covering a wide range of capacity and pressure. Combustion Engineering Co., Inc.

Diesels and Lubrication

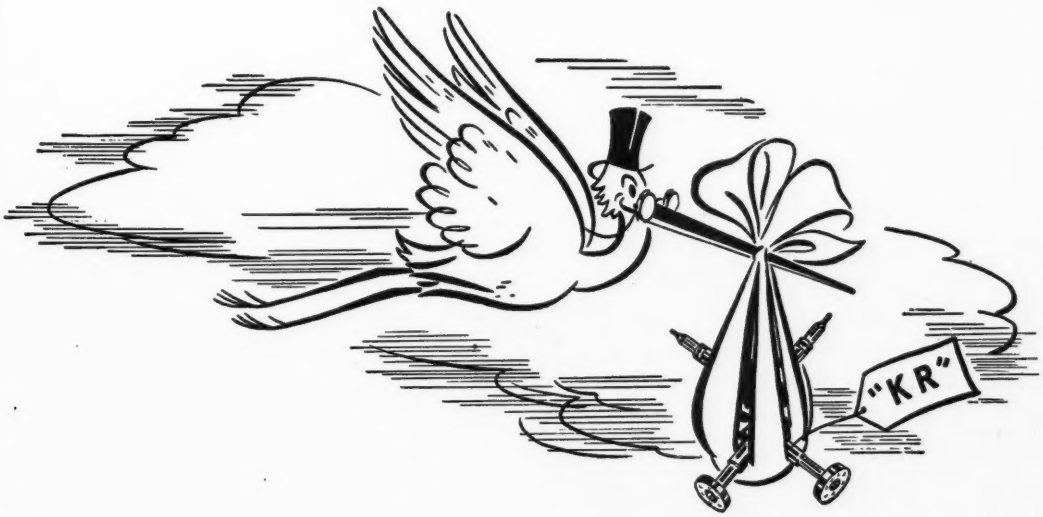
19 **Diesels**—Bulletin 5182, a new 36 pp. catalog, done up attractively in three colors, fully describes various models of industrial Diesel engines. Included with illustrations and specifications of the engines, a section of the catalog is devoted to generating sets and accessories. Cummins Engine Co.

20 **Diesels**—A new 8 pp. bulletin No. 764 illustrates and describes the type 16 CP Diesel engine. This new engine, incorporated with the latest construction developments and combustion control, was designed especially for continuous duty and may be converted into a gas engine. Chicago Pneumatic Tool Co.

21 **Lubrication Equipment**—A new line of Bowser devices called Self Contained Lubricating Units is described and illustrated in a new 8 pp. colored bulletin. The units are made in numerous sizes and types to meet all conditions of service and are designed to do the following: Store the oil; pump it; filter it; and circulate it to the machines. S. F. Bowser & Co., Inc.

22 **Ferro Filter**—Bulletin 16 is a 4 pp. folder describing the new low price series PQ Frantz Permanent Magnet Ferro Filter for lube oil purification. These filters, which are said to extract iron particles as fine as 1/25,000 of an inch in diameter, are set close to the engine in the oil pipe line and become part of the lubricating system. S. G. Frantz Co., Inc.

23 **Chemical**—Siloo and Loosite, solvents used to dissolve gums, that form in lubricating and fuel oils, and sludge that gathers in containers and passages, are discussed in a bulletin entitled Engineering Reports on Thermal Efficiency by W. O. Hebler, issued by the Petroleum Solvents Corp.



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	Yield Strength 1000 psi	Tensile Strength 1000 psi	Elong. % in 2"	Hardness BHN 3000 Kg.
Hot rolled	40-85	90-120	45-30	140-225
Hot rolled, age hardened	90-120	135-160	30-20	260-300
Cold drawn	70-100	100-125	35-15	175-250
Cold drawn, age hardened	100-130	140-170	30-15	260-320

**Trade-mark of The International Nickel Company, Inc.*

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Industrial Process Equipment

25 Welding Fittings—Bulletin WF-41, a recent release, printed in two colors, illustrates and describes a complete line of butt-welded fittings, among which are elbows, reducers, tees, crosses, 45 deg. laterals, stub ends, caps, nipples, saddles and sleeves and forged steel flanges. Also included is a price list and dimensions of the various fittings. Midwest Piping & Supply Co., Inc.

26 Varnish—Harvel 612-C Insulating Varnish is the title of recently released folder which illustrates and describes a recently developed, internal drying, synthetic resinous phenol—aldehyde type varnish. The folder gives specific technical data on its performance under severe conditions, and also includes data on proper methods of application giving suggested schedules for baking. Irvington Varnish & Insulator Co.

27 Water Cooling—Water conservation equipment is described in a new 8 pp. catalog, included among which are mechanical draft cooling towers, atmospheric cooling towers, spray nozzle cooling systems and roof cooling systems. The principle of the roof cooling system is the dissipation of the exterior solar heat which would otherwise be transferred through the building roof. Water Cooling Corp.

28 Dryer—A new catalog and engineering data book, No. 1911, entitled Link-Belt Roto-Louvre Dryer, recommended for the drying of coal, ore, sand, granules, powders, pulps, earths, cereals, sugars, fruits, starches, seeds, pomaces and many other products of the mine, chemical, food and agricultural industries, may also be used as a cooler. Link-Belt Company.

29 Drying Equipment—New 8 pp. bulletin D-1 describes the Turbulaire Dispersion Dryer. Fully illustrated, the catalog covers drying of slimes, pulps, press cakes, industrial wastes and many technical chemicals. Western Precipitation Corp.

PREPARE YOUR COAL
FOR *Better* COMBUSTION
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RING CRUSHERS

One of the surest ways to bring lower plant operating costs is to prepare coal for better sizing and take full advantage of improved combustion efficiencies.

AMERICAN Ring Crushers can help do this. They reduce in one operation run-of-mine or lump coal to the proper sizes required for unit pulverizers and automatic stokers. Scores of AMERICAN users report savings in total fuel costs from 2½ to 8%.

Plan now to take advantage of these important boiler room economies. Our engineers will gladly place you in touch with "AMERICAN" equipped plants where you will be given every opportunity to check the actual savings being effected.

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

30 Gears—A new 112 pp. handy pocket size catalog describes various types of gears, sprockets, speed reducers, couplings, bearings and chains. Thoroughly illustrated, this catalog also includes data on gear tooth parts and key seats, also various types of micrometers, calipers, thread and thickness gages. Atlantic Gear Works, Inc.

31 Pumps—A new industrial catalog in sectionalized form, illustrates and describes centrifugal, reciprocating, rotary and sump pumps. Also included are condensate return units, and many other applications. Goulds Pumps, Inc.

32 Steam Cleaners—Steam cleaners and their application in plants, factories, and shops are described in a bulletin under the title "Hypressure Jenny." This unit either stationary or mounted on a hand-drawn truck, employs a steam vapor spray, highly atomized hot water, pressure and a cleaning compound to dissolve, cut and flush grease and dirt from surfaces. Homestead Valve Mfg. Co.

Miscellaneous

33 Coal Carrier—The Tramrail Raise-Lower Cab Carrier is illustrated and described in a recently released folder. This carrier makes it possible for one operator to handle all operations involved in moving materials with a cab-controlled overhead tramrail system. The carriers are available in two general forms. One permits raising and lowering the cab and load independently of each other, while the other provides for the raising and lowering of the cab and load together. Cleveland Crane & Engineering Co.

34 Cranes—A new 24 pp. catalog entitled Euclid Cranes, discusses technically the latest developments in the crane industry. Fully illustrated, this catalog describes in detail, bridges, trolleys, magnetic controls, various heavy and moderate duty cranes, auxiliary hoists and low headroom cranes. Euclid Crane & Hoist Co.

35 Metals—Allegheny Ludlum Stainless Steels are dealt with in a series of bulletins recently issued. One interesting pamphlet on fabrication was prepared from laboratory and service tests and deals with the metal requirements for such processes as welding, drawing, machining, spinning, upsetting, forging, soldering, annealing and surface treatment. Other bulletins deal with qualities of specific alloys and their uses. Allegheny Ludlum Steel Corp.

36 Metal Drawing—Deep drawing, shearing and perforating of Monel, Nickel and Inconel for tanks, sinks, cups, shells and the like is discussed and the requirements for satisfactory work are described in Bulletin T-19 issued recently. The International Nickel Co., Inc.

37 Air Conditioning—Bulletins 105 and 111 give information on scientific odor control, with comparison of costs of conditioning outside air as against recirculating conditioned air. Also principles and use of the Dorex Adsorber for reducing the amount of outside air needed in a system. Dorex Division, W. B. Connor Engineering Corp.

38 Cooling and Ventilating—New 1941 Wagner fan catalog FU-41 illustrates and describes the complete line of Wagner cooling and ventilating equipment for 1941. The 20 pp. bulletin gives installation and application data, making it especially helpful to dealers and contractors. Wagner Electric Corp.

39 Heating and Cooling—Six new bulletins were recently published on Niagara equipment. These include the following: Bulletin 82, Type X, Series 2800-S heating conditioner; Bulletin 83 on the No-Frost method for pre-cooling humidifying, chilling, holding or freezing; Bulletin 84 on Downblast Heaters, Series 4000; Bulletin 85 on Disk Fan Heaters, Series 4200 and 4300; Bulletin 86, Directions for operating spray coolers with galvanized steel coils with salt or calcium spray liquid; Bulletin 87, similar to Bulletin 86, except applicable to aluminum coils. Niagara Blower Co.

Smooth-On Savings

Sealing a bad crack in a pump-casing with SMOOTH-ON No. 1

Here's a crack that would seem to make a new pump casing necessary or at least require a welded repair. But Smooth-On No. 1 permits a quicker, less costly repair.

The repair consists of simply tamping a stiff putty of Smooth-On No. 1 into the crack. No dismantling, heat, or special equipment is necessary.

On hardening, the Smooth-On expands against the sides of the crack to make a tight seal. The reinforcing plate is not necessary for short cracks.

FREE

The Smooth-On Handbook—40 pages, 170 diagrams—full of time-saving, labor-saving, and money-saving suggestions for practical, ingenious repairs. Every engineer should have a copy of this useful manual, sent free on request.

Smooth-On No. 1 has dozens of applications around the plant for making loose parts tight, repairing cracks in metal, and stopping leaks in boilers, heaters, tanks, valves, pipe lines, etc. It can be used on any metal or wood, withstands water, steam, oil, gasoline, or fire, and holds under pressure or vacuum. Buy Smooth-On No. 1 in 7-oz., 1-lb., 5-lb. cans, or 25-lb., 100-lb. kegs from your dealer or if necessary, from us. For your protection, insist on Smooth-On, used by engineers since 1895.

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3-41

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New Engineering Books

Welding Metallurgy. By O. H. Henry and G. E. Claussen. 259 pages illustrated, size 5 by 8, bound in simulated leather. Published by the American Welding Society, 33 W. 39th street, New York, N. Y. 1940.

This book is intended to familiarize members of the welding industries, including fabricators and designers, with the composition and structure of the steel they use, to show how the steel is affected by the varied conditions of heat and stress in welding, to explain the mysteries of heat treatment, and to point out the way in which metallurgy can be used to control welding processes No prior instruction in metallurgy is assumed nor is a detailed acquaintance with welding technique required.

National Electrical Code Handbook. By Arthur L. Abbott. Fifth Edition. 595 pages, illustrated, semi-flexible imitation leather, 5 by 7½ in. McGraw-Hill Book Co., Inc., 330 W. 42nd street, New York, N. Y., 1940. Price $3.00.

The purpose of this book is to enable the reader to grasp readily the general plan, scope and intent of the National Electrical Code requirements and to present more or less detailed discussions of the rules whenever anything of practical value can be contributed by such discussion. Also, the book endeavors to make the practical application of the code rules clear and easily understandable. It is intended for general use as a reference book and as a textbook for individuals and classes taking up a systematic study of the code.

The National Electrical Code itself is not included in this book. Since the code is available to everybody at a nominal price, the author feels that it is unnecessary to include a word for word reprint of the code. All requirements of the code are included, however, though in some cases the rules have been reworded.

It is a book that every electrician should be familiar with.

Leather Belting Research. During America's period of greatest industrial expansion, leather belting was considered the major means of power transmission and to give most driving power for the energy consumed. Because belting manufacturers neglected to continue efforts to improve the manufacture of and results from leather belt transmission, other forms of transmission pushed ahead, and leather belting lost something in prestige. But a number of belt manufacturers kept up research to improve the coefficient of friction of leather belting and the maximum transmission of power per dollar of expenditure.

This has resulted in what is termed "the production drive" consisting of highest quality short-center leather belt operated in connection with a pivoted motor base, which has been fully tested and proved. Also various forms of "tread" for the bearing surface of belts have been developed, which are claimed to increase friction between belts and pulleys.

To tell users of belting what this new form of drive will do for them, an illustrated book has been printed for free distribution to those interested in increasing production without increasing costs, and will be sent free to readers who request it from POWER PLANT ENGINEERING Service Department, Chicago, Ill.

Index To A.S.T.M. Standards. This is a 152 pp. paper bound book arranged as an index to 952 standards and tentative standards available at the end of 1940. The Index is arranged alphabetically according to the particular subject covered by the standard and also with the specifications and tests arranged in numerical sequence of their serial designations. This book is available, free of charge, on written request to the A.S.T.M. headquarters, 260 S. Broad St., Philadelphia.

Scale Formation in Water Heaters and Methods of Prevention are discussed in the Engineering Bulletin of Purdue University, Lafayette, Ind., Research Series No 14, by J. M. Krappe. He deals with tests on various types of heaters and outlines arrangements of equipment to prevent scale formation, also methods of scale removal. 22 pages. Price 25 cents.

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Heat Transfer by Radiation was treated in a series of 4 lectures at Purdue University by Professor W. J. Wohlenberg of Yale University, covering; Nature of Radiation and Interchanges Between Surfaces; Distribution of Energy and Radiation from Gases; Equations for Net Interchange by Radiation; Distribution of Energy in Pulverized Coal Furnaces. The text and illustrations cover 67 pp. and are contained in Research Series No. 75 of the Experiment Station of Purdue University, Lafayette, Ind. Price 25 cents.

Plant Directory. Federal Power Commission, Washington, D. C. has issued a directory of generating plants and a map of plants and transmission lines. Price $1. Also a larger map 4½ by 7 ft. in ten colors. Price $2.50. The directory lists 1922 utility plants of 1000 kw. and over, with classification by age, equipment and ownership.

Standards for the Pump Industry, 7th edition, rewritten and rearranged contains a new pump test code, charts for friction of petroleum in pipe lines, pump-speed curves, pressure-temperature curves for hot water, resistance of valves and fittings. The complete book is priced at $1.25 net. But it is prepared in sections which can be had separately as follows: General section on classification and applications, 35 cts ; centrifugal pump section, 50 cts.; rotary pump section, 25 cts.; reciprocating pump section 25 cts.; deep-well turbine section, 25 cts.; test codes for centrifugal rotary and reciprocating pumps, 50 cts.; Data Section on pipe friction, fittings resistance, viscosity, water properties, 50 cts. In all cases, postage must be added to the prices given. Sections or book may be ordered from C. C. Rohrbach, Secretary, The Hydraulic Institute, 90 West St., New York, N. Y.

Temperature—Its Measurement and Control in Science and Industry. Symposium of the American Institute of Physics. Published by the Reinhold Publishing Corp., 330 W. 42nd St., New York, N. Y. Size 6 by 9 in.; 1292 pp. plus 70 pp. of appendix, glossary and index; cloth bound. Price $11 00.

While excellent engineering and scientific books are now common, seldom need a reviewer feel at a loss for words to do justice to a specific volume. Yet the magnitude of this work, its scope and treatment baffle description—it is a monument to organized engineering societies and in itself justification of the time and effort spent to develop them to their present status of usefulness.

No one author could have written such a book, no company could have produced such a book as a commercial venture, for it represents the present world knowledge of temperature measurement and control as used in practice, in research laboratories, educational institutions, manufacturing plants and general industry from the Atlantic to the Pacific.

It is made up of some 125 separate papers and their discussion, of a symposium held in New York by the American Institute of Physics with the co-operation of the National Bureau of Standards, the National Research Council, with officers and committees from 12 other national engineering societies, on the 20th anniversary of the equally important Symposium on Pyrometry.

These 125 papers are arranged in 13 chapters covering, among other things: the theory, design, application and calibration of all types of temperature measuring devices from the common glass thermometer to two color optical pyrometers; automatic temperature regulation and recording; education and training of technicians; and practical application in research and industry.

Among the latter, the general engineering, metal and ceramic industries, oil industries and special applications hold the most interest to the engineer. They deal with practical phases of temperature measurement and control in specific applications such as: boiler gas measurements with the high velocity thermocouple; hygrometric, dewpoint and air conditioning; stoker fuel beds; steam turbines; cracking steel tubes; pyrometric cones; the quick immersion technique for high temperature fluid measurements; flame temperature, concrete structures, etc.

While no review can do justice to such a book, it can be said without fear of contradiction that no engineer, concerned with, or, responsible for research or industrial processes where temperature measurement and its control are important, can afford to be without this book—either in his own library or company library where it is readily available.

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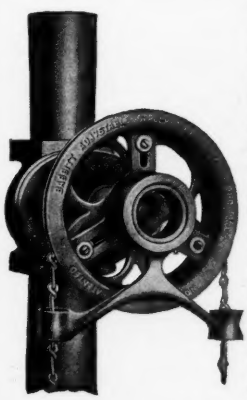

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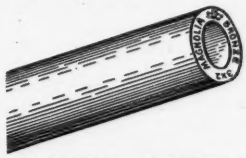

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Power Plant Construction News

Ala., Birmingham—Alabama Power Co., Birmingham, is providing appropriation of about $6,500,000 for expansion and improvements in power plants and system during 1941, of which approximately $2,000,000 will be used for completion and installation of equipment in new steam-electric power plant, now in course of construction at Mobile, Ala.

Ariz., Parker—Bureau of Reclamation, Denver, Colo., is asking bids until March 10 for main station-service and station-power control equipment; generator-voltage bus structures; and metalclad switchgear for hydro electric power plant at Parker Dam, Parker, Arizona-California (Specifications 952).

Calif., San Francisco—Independent Ice Co., 630 Twenty-ninth Avenue, Oakland, Calif., plans early construction of new one-story ice-manufacturing and refrigerating plant at San Francisco. Cost reported close to $50,000, with equipment. J. B. Anthony, 462 Elwood Avenue, Oakland, is architect.

Colo., Las Animas—City Council will begin work soon on new municipal electric power plant, for which a bond issue of $275,000 was recently authorized. E. T. Archer & Co., New England Building, Kansas City, Mo., are consulting engineers.

Conn., Greenwich—Building Committee, Greenwich Hospital Association, plans power plant at new five-story hospital. Bids will be asked soon. Entire project will cost close to $1,000,000. Crow, Lewis & Wick, 200 Fifth Avenue, New York, N. Y., are architects.

Conn., Hartford—Hartford Electric Light Co., 266 Pearl Street, has plans under way for large addition to steam-electric generating station at South Meadows, with installation of new 45,000-kw. turbine-generator unit, high-pressure boilers and auxiliary equipment. Work will begin this year. Stone & Webster Engineering Corporation, 49 Federal Street Boston, Mass., is consulting engineer.

Ill., Peoria—Caterpillar Tractor Co., plans installation of electric power equipment in new one-story addition to tractor and road scraper-manufacturing plant. Erection will begin soon. Entire project is reported to cost over $175,000.

Ind., Fort Wayne—Wayne Paper Box & Printing Co., Superior and Calhoun Streets, plans installation of electric power equipment in four-story addition to paper box-manufacturing plant, 70x115 ft. Cost reported close to $100,000. Work will be placed under way at early date. Pohlmeyer & Pohlmeyer, Central Building, Fort Wayne, are architects.

Iowa, Earlville—Common Council has surveys and estimates of cost under way for proposed municipal electric power plant. Planned to use Diesel engine-generator units and accessories. Work is scheduled to begin in April. A. S. Harrington, Baum Building, Omaha, Neb., is consulting engineer.

Iowa, Maquoketa—City Council will receive bids until March 11 for one heavy-duty Diesel oil engine unit, about 1200-hp. rating, direct-connected to a.c. generating unit, and accessory equipment; chain-drive exciter, piping, valves, exhaust heat boiler, water supply system, etc., for municipal power station. (Bids previously asked have been rejected.) Cost estimated close to $75,000. J. G. Thomas is city clerk.

Kan., Kansas City—North American Aviation, Inc., Inglewood, Calif., plans power house, about 6000 sq. ft of floor space, at new branch plant at Reimer and Fairfax Roads, Kansas City, for assembling of airplane bombers for Government. Electric power equipment will be installed in main one-story assembling building, 928x 1061 ft., and other plant structures. En-

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tire project will cost about $10,000,000. Allen & Kelly, Architects' and Builders' Building, Indianapolis, Ind., are architects. Fund is being provided by Government for project.

Ky., Louisville—Louisville Gas & Electric Co., has plans under way for new steam-electric generating station on site on Ohio River, with installation of turbine-generator units of large capacity, high-pressure boilers and auxiliary equipment. Entire project is reported to cost about $5,500,000. Proposed to begin work in 1941 as part of expansion and improvement program for year.

Md., Baltimore — Bethlehem-Fairfield Shipyard, Inc, an interest of Bethlehem Steel Co., Shipbuilding Division, 1101 Key Highway, recently organized, plans power house at new shipbuilding plant at Fairfield, near Baltimore, where company will take over property of former Union Shipbuilding Co. A total of 13 shipways, with shops and other structures will be built; electric power equipment will be installed. New yard will be used for construction of vessels for Government and will cost about $7,838,000; a Federal fund in that amount has been approved.

Mass., Pittsfield—Berkshire Woolen Co., Pecks Road, has completed plans for new power house at mill and will proceed with erection at early date. Cost reported about $130,000, with boiler units and auxiliary equipment.

Mich., Hastings — Village Council has preliminary plans under way for new municipal power plant. Proposed to use Diesel engine-generator units and accessories. Cost reported about $145,000. Francis Engineering Co., Saginaw, Mich., is consulting engineer.

Ohio, Bluffton — Central Ohio Power & Light Co., Findlay, Ohio, has plans under way for expansion in steam-electric generating plant at Bluffton, including installation of additional equipment for increased capacity. Cost close to $700,000. Proposed to begin work soon.

Ohio, North Baltimore — Village Council is completing plans for new municipal power plant and work on project is scheduled to begin at early date. Diesel engine-generating units and auxiliary equipment will be installed. Cost estimated close to $210,000. C. J. Simon & Associates, Evans-Central Building, Van Wert, Ohio, are consulting engineers.

Pa., Easton — C. K. Williams & Co., Inc., North Thirteenth Street, manufacturer of chemicals, colors, etc., has plans maturing for new steam power house at plant, with installation to include boiler units and auxiliary equipment. Cost reported over $125,000, with equipment. Lockwood, Greene Engineers, Inc., 10 Rockefeller Plaza, New York, N. Y., is consulting engineer.

S. D., Britton—Britton Commercial Club, Roy Stiles, secretary, is interested in a project to construct and operate a municipal power plant, estimated to cost over $150,000. Planned to use Diesel engine-generator units and accessories. It is proposed to have municipality call special election at early date to vote bonds for plant.

Texas, Houston — American Rolling Mill Co., Middletown, Ohio, plans power house at new steel mill on 600-acre tract near ship channel, Houston, now being acquired. Also will install electric power equipment in group of buildings to be erected for structural mill, plate mill, bar mill and other production service. Entire project will cost about $17,000,000 of which approximately $12,000,000 will be arranged through RFC loan. Plant will be operated under direction of Sheffield Steel Corporation, Sheffield Station, Kansas City, Mo., a subsidiary interest. Work will begin soon.

Texas, Port Arthur—Sabine Steel & Construction Corporation, 320 Seventh Street, Port Arthur, plans installation of electric power equipment in new one-story fabricating mill at West Port Arthur, where site is being secured. Entire project will cost about $100,000.

Va., Norfolk — Virginia Electric & Power Co., Richmond, Va., has plans under way for expansion in steam-electric power plant on Reeves Avenue, Norfolk, with installation of new turbine-generator unit, high-pressure boilers and auxiliary equipment. Cost reported about $4,000,000. Work will be carried out as part of 1941 expansion program of company.

Wis., Milwaukee — Swift & Co., Union Stock Yards, Chicago, Ill., meat-packers, plan installation of electric power equipment in new additions to plant on Second Street, Milwaukee, consisting of a six-story and five-story unit, respectively, 120x140 ft., and 140x182 ft., in order noted. Entire project reported to cost over $450,000. Proposed to begin work soon.

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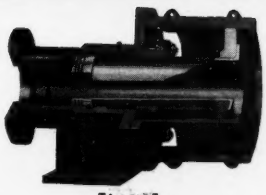

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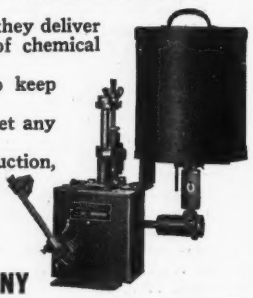

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